

ADA 023 473

AD-A023 47

RIA-76-U268

76

TECHNICAL  
LIBRARY



## EVALUATION OF GROOVED SOLID LUBRICATED BEARINGS

LUBRICATION BRANCH  
FUELS AND LUBRICATION DIVISION

FEBRUARY 1976

TECHNICAL REPORT AFAPL-TR-75-76  
TECHNICAL REPORT THRU JULY 1975

Approved for public release; distribution unlimited

AIR FORCE AERO-PROPULSION LABORATORY  
AIR FORCE WRIGHT AERONAUTICAL LABORATORIES  
Air Force Systems Command  
Wright-Patterson Air Force Base, Ohio 45433

NOTICE

When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

This report contains the results of an effort to investigate the performance of solid lubricated ball bearings under high speed conditions. The work was performed in the Fuels and Lubrication Division of the Air Force Aero Propulsion Laboratory, Air Force Wright Aeronautical Laboratories, Air Force Systems Command, Wright-Patterson AFB, Ohio, under Project 3048, Task 304806 and Work Unit 30480619. The effort was conducted by Mr. Mac A. Sheets/SFL and Mr. Ronald D. Dayton/SFL during the period July 72 to June 75.

Acknowledgement is hereby given to Mr. C. W. Smiley and Mr. S. R. Jackson for the conduct of the reported tests and for their otherwise very generous support to this program; to Mr. D. B. Elkins who balanced the solid lubricated bearing retainers and test rig drive shaft, and to various members of the AFAPL Zone Shop (LGUZA) who supported our effort through the fabrication and modification of various required items.

This report has been reviewed by the Information Office (ASD/OIP) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

R.D. Dayton

R. D. DAYTON, GS-12  
Project Engineer

M. A. Sheets

M. A. SHEETS, GS-12  
Project Engineer

FOR THE COMMANDER

Howard F. Jones

HOWARD F. JONES, Chief  
Lubrication Branch  
Fuels and Lubrication Division

Copies of this report should not be returned unless return is required by security considerations, contractual obligations, or notice on a specific document.

## UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER AFAPL-TR-75-76	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) EVALUATION OF GROOVED SOLID LUBRICATED BEARINGS		5. TYPE OF REPORT & PERIOD COVERED Technical Report thru July 1975
7. AUTHOR(s) RONALD D. DAYTON MAC A. SHEETS		6. PERFORMING ORG. REPORT NUMBER
9. PERFORMING ORGANIZATION NAME AND ADDRESS Air Force Aero-Propulsion Laboratory Air Force Wright Aeronautical Laboratories Air Force Systems Command Wright-Patterson AFB, Ohio 45433		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 3048 06 19
11. CONTROLLING OFFICE NAME AND ADDRESS Air Force Aero Propulsion Laboratory Air Force Wright Aeronautical Laboratories Air Force Systems Command Wright-Patterson Air Force Base, Ohio 45433		12. REPORT DATE FEBRUARY 1976
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		13. NUMBER OF PAGES 79
		15. SECURITY CLASS. (of this report) Unclassified
		15e. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report)  Approved for public release distribution unlimited		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Solid Film Lubrication Bearing Design Bearing Cooling Techniques Bearings-Heat Generation in Heat Transfer		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report describes an evaluation of solid lubricated bearings having grooved inner races. The intent of these grooves was to pump ambient air into the bearing, thus lowering stabilized operating temperatures and providing a means of heat dissipation. Nineteen series of tests were run with grooved and ungrooved bearings over a range of bearing loads and speeds. Bearing stabilization temperature and torque were monitored at each load-speed operating condition. Speeds were varied between 7500 and 30,000 RPM. Axial loads ranged		

**UNCLASSIFIED**

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

between 75 and 150 pounds. Radial loads varied from zero to 75 pounds. Solid lubrication was provided using retainers of either a silver-mercury-teflon-molybdenum diselenide composite or a gallium-indium-tungsten diselenide compact. Bearing cage unbalance problems prevented a determination of groove effectiveness relative to cooler bearing operation. Speed had a predominant effect on bearing operating temperature and torque. The effects of bearing load and cage material were considerably less.

In addition, five duration tests were conducted at 40,000 RPM. A bearing life of 14.5 hours was achieved at this speed with an axial load of 100 pounds.

**UNCLASSIFIED**

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

## TABLE OF CONTENTS

SECTION	PAGE
INTRODUCTION	1
DESCRIPTION OF TEST RIG	3
1. GENERAL	3
2. BASIC DESIGN	3
3. LOADING AND SUPPORT SYSTEM	7
4. BEARING TORQUE MEASUREMENT	7
5. INNER RACE TEMPERATURE MEASUREMENT	8
6. DRIVE SYSTEM	8
7. TEST BEARING AND RETAINERS	8
TEST PROCEDURE	12
1. TEST BEARING PREPARATION	12
2. TEST START-UP AND RUNNING SEQUENCE	12
DISCUSSION OF RESULTS	14
1. GENERAL COMMENTS	14
2. BEARING RETAINER MATERIAL EFFECTS	14
3. BEARING LOAD EFFECTS	25
4. SPEED EFFECTS	25
5. BEARING HEAT GENERATION	32
6. 40,000 RPM TESTS	32
CONCLUSIONS AND RECOMMENDATIONS	43
LIST OF REFERENCES	44
APPENDIX	45

## LIST OF ILLUSTRATIONS

FIGURE	PAGE NO.
1	4
2	5
3	6
4	9
5	9
6	10
7	11
8	16
9	17
10	18
11	19
12	20
13	21
14	22
15	23
16	24
17	26
18	27

19	VARIATION OF AVERAGE BEARING TORQUE WITH BEARING AXIAL LOAD AT CONSTANT SPEED	28
20	VARIATION OF AVERAGE BEARING TORQUE WITH BEARING RADIAL LOAD AT CONSTANT SPEED	29
21	VARIATION OF AVERAGE BEARING OUTER RACE TEMPERATURE WITH SPEED	30
22	VARIATION OF AVERAGE BEARING TORQUE WITH SPEED	31
23	BEARING HEAT GENERATION OF SMALL CLEARANCE AgHg BEARINGS AT VARIOUS SPEEDS	35
24	BEARING HEAT GENERATION OF LARGE CLEARANCE AgHg BEARINGS AT VARIOUS SPEEDS	36
25	BEARING HEAT GENERATION OF SMALL CLEARANCE WGI BEARINGS AT VARIOUS SPEEDS	37
26	BEARING HEAT GENERATION OF LARGE CLEARANCE WGI BEARINGS AT VARIOUS SPEEDS	38
27	VARIATION OF BEARING OUTER RACE TEMPERATURE WITH TIME FOR AgHg BEARING OPERATING AT 40,000 RPM	39
28	VARIATION OF BEARING TORQUE WITH TIME FOR AgHg BEARING OPERATING AT 40,000 RPM	40
29	VARIATION OF BEARING HEAT GENERATION WITH TIME FOR AgHg BEARING OPERATING AT 40,000 RPM	41
30	VARIATION OF BEARING OUTER RACE TEMPERATURE, TORQUE AND HEAT GENERATION WITH TIME OF A AgHg BEARING OPERATING AT 40,000 RPM	42

#### LIST OF TABLES

TABLE		PAGE NO.
I	TEST SERIES SUMMARY	15
II	BEARING HEAT GENERATION CALCULATIONS	34

## INTRODUCTION

Solid lubricated bearings offer potential for use in a wide range of applications where reduced maintenance is desired or operating and environmental conditions are such that conventional lubricants cannot be used satisfactorily. Both of these major considerations are pertinent where aerospace applications are concerned. Self lubricating bearings are of a sacrificial nature in that the lubricant is gradually depleted during usage. Their greatest potential is seen to be in those applications which have limited operating life requirements. These would include such things as small expendable engines, alternators, drones, missiles, remotely piloted vehicles etc. However, most of these applications involve high operating speeds and/or high temperature conditions. These represent severe conditions under which the bearings must perform, and are also conducive to excessive bearing heat generation during operation. It is to this problem that this investigation was directed.

The primary intent of this investigation was to determine if grooves in the bearing inner race would reduce bearing operating temperatures and heat generation by pumping relatively cool air into the bearing between the bearing retainer and inner race. A series of tests were conducted over a range of speed and load conditions to determine bearing stabilized operating temperatures. Bearing torque was monitored continuously. Other variables included in this study were bearing internal clearance, cage to land clearance, ball hole clearance, and groove depth. Bearing retainers made from silver-mercury-Teflon-molybdenum diselenide, and gallium-indium-tungsten diselenide composites were used to provide lubrication. Duration tests at a speed of

40,000 RPM were also attempted with grooved and ungrooved bearings. It was hoped at this speed that any beneficial effects of the grooves would be more apparent than previous data indicated. The duration test approach was taken since virtually no bearing performance information was available above 30,000 RPM.

## DESCRIPTION OF TEST RIG

### 1. General

The basic test facility, which was designed and built by Southwest Research Inst. consisted of an air turbine to drive the test bearing, a bearing chamber, an oil system (which obviously was not required for the solid lube tests), bearing loading system, bearing heater (which also wasn't utilized for these tests), and the necessary instrumentation and controls. Photographs of the test facility are shown in Figures 1 and 2.

### 2. Basic Design

A detailed schematic of the rolling element bearing test rig is shown in Figure 3. The test bearing, A, is driven by the main shaft, B, which is powered by an air turbine, C. Air to the turbine is supplied by an auxiliary compressor via the nozzle ring, D. Externally-pressurized, orifice-compensated air bearings, having low friction characteristics at high speeds, are shown as E and F, and are employed to support the main shaft during operation. The outer race of the test bearing is supported in the test bearing holder, G, which is held in the test chamber, H. Thrust load is applied to the test bearing by the axial load piston, I, and radial load by the radial load pad, J. The test chamber is externally supported by two hydrostatic air bearings: the axial support pad, K, and the radial load pad, J, which serves a dual purpose in that it supports the test chamber in the radial direction on a hydrostatic air film and also applies a radial load through the air film to the test bearing. A shaft extension, L, extends through the test chamber lid and serves as the driver for the rotary transformer, M. The shaft extension, L, is hollow and provides a path for the electrical conductors from the inner race (test bearing) temperature transducer to the rotary transformer. A magnetic pickup, N, monitors the speed of the main shaft, B.

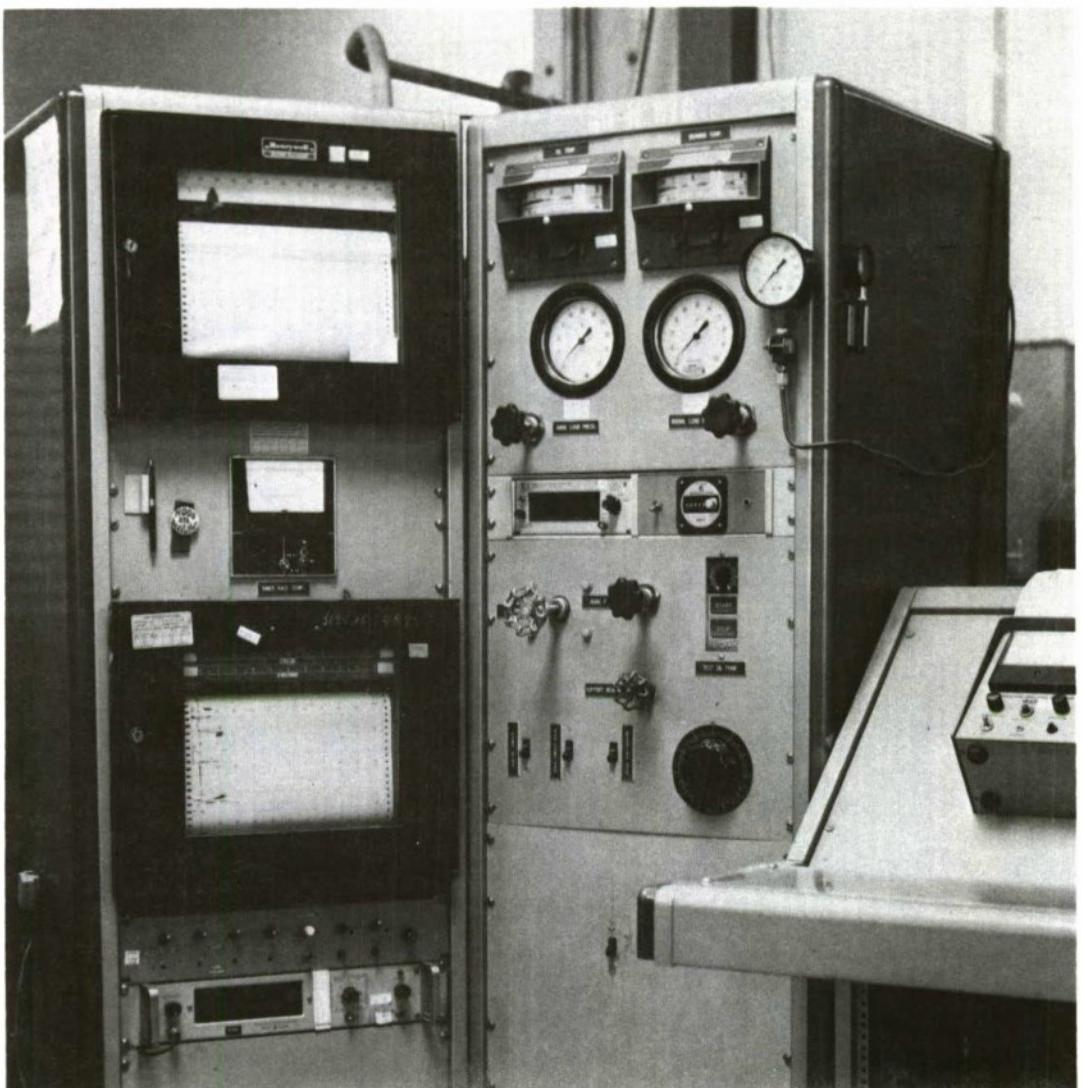


Figure 1. Solid Lube Bearing Test Facility Console

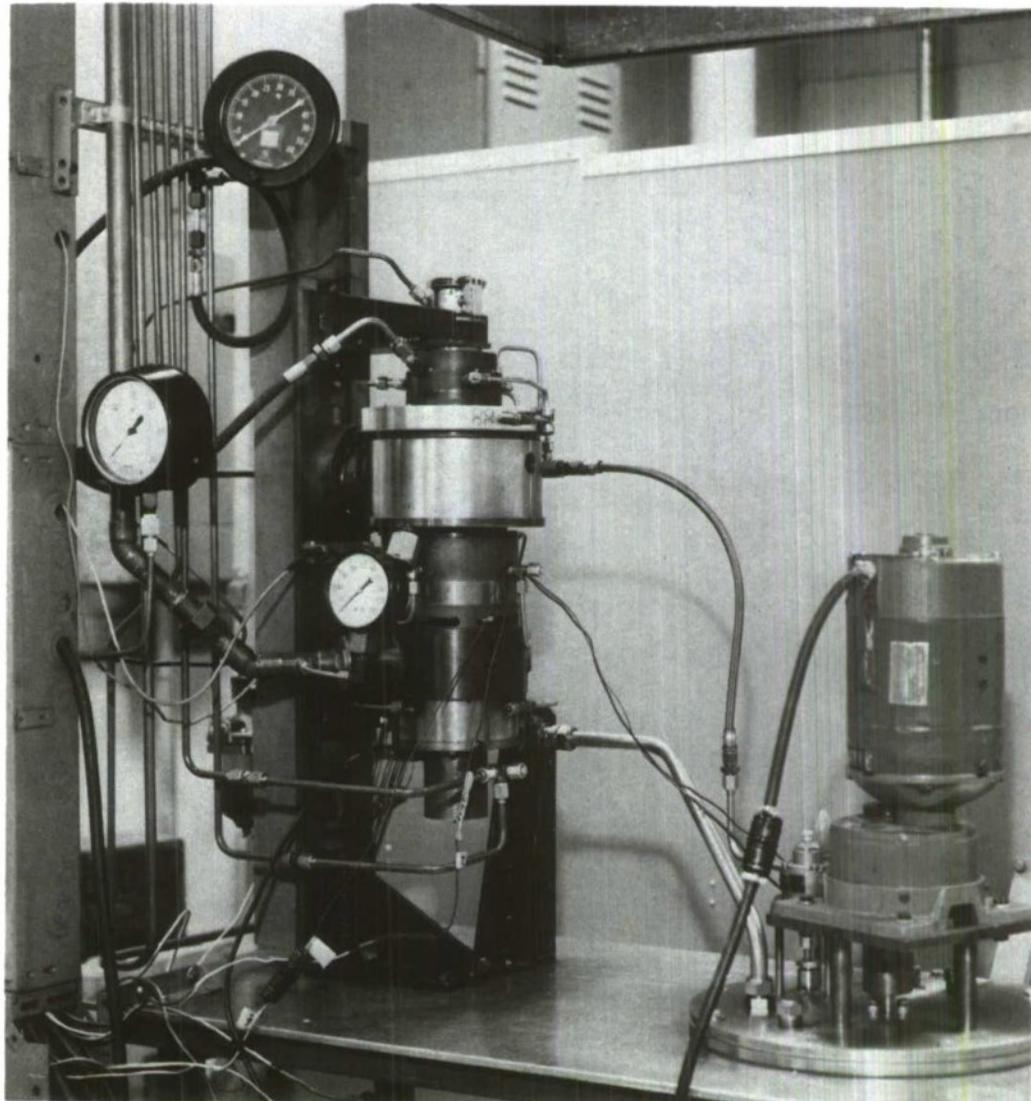


Figure 2. Solid Lube Bearing Test Facility Rig

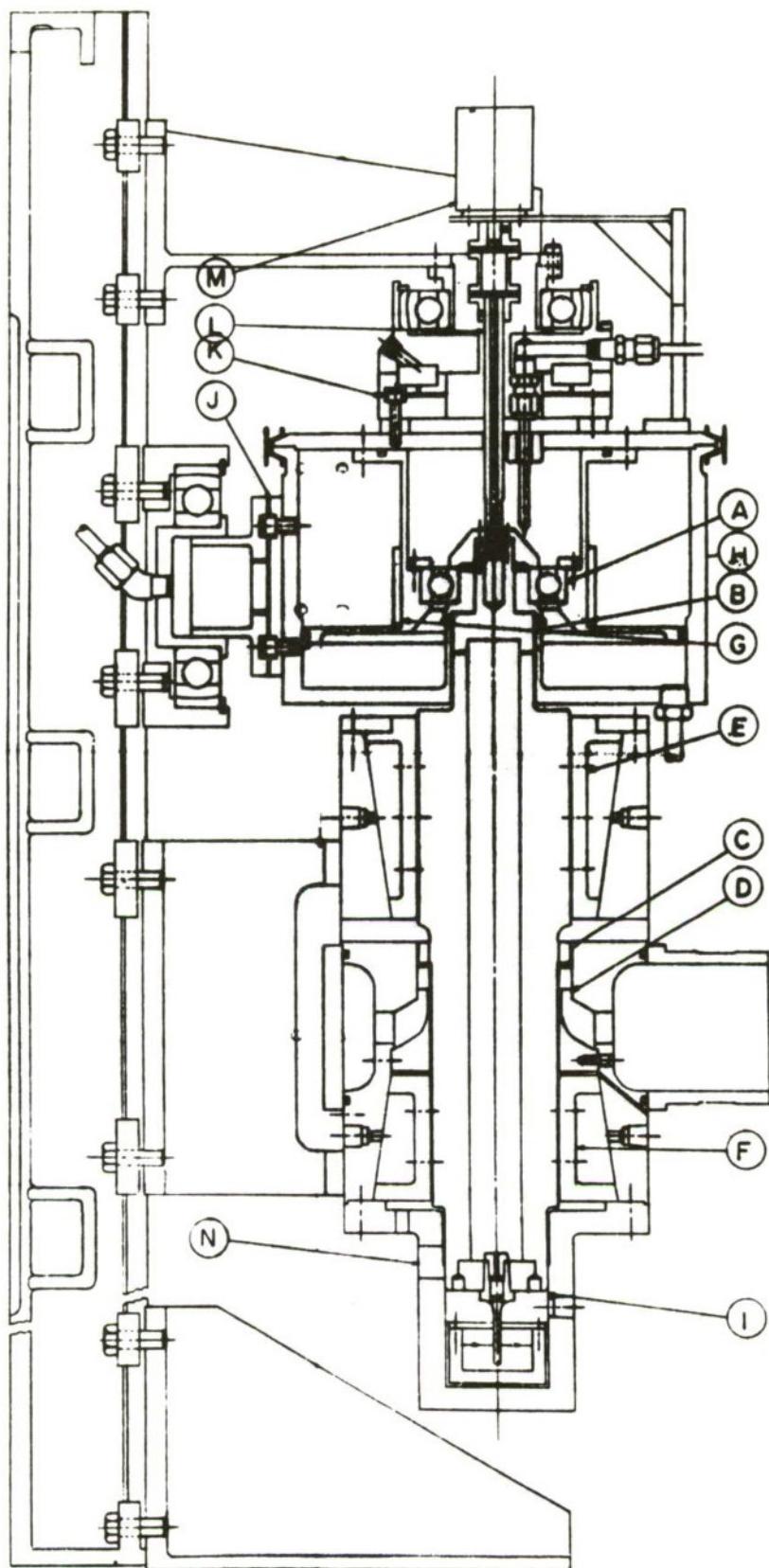


Figure 3. Schematic of Rolling Element Bearing Test Rig

### 3. Loading and Support System

The test rig was designed to allow the application of independently controlled thrust and radial loads on the test bearing. The thrust load, applied by means of the axial load piston, I, and the radial load applied by the radial load pad, J, are controlled with hand operated pressure regulators mounted in the instrument console. The amount of radial or thrust load is determined by the known piston size and the applied pressure which is indicated on the gauges in the instrument console.

Filtered air is supplied to the two support air bearings, E and F, through an air manifold. These bearings are orifice compensated and were designed to operate at 200 to 250 psig on clean dry air. Practical operating experience has shown that if the supply air is contaminated with either water or oil the high speed capability of the rig is severely reduced due to the deleterious effects of these contaminants on the solid lubricant coating which is applied to the journal surfaces of the air bearings.

### 4. Bearing Torque Measurement

Torque due to test bearing friction, which tends to rotate the test chamber, H, is measured with strain gages which are attached to a metal leaf spring. The leaf spring deflects when torsional load is applied and produces a resistance change in the strain gage bridge, which in turn gives an electrical output that is calibrated and employed as a measure of bearing torque. Since the radial and axial hydrostatic air pads offer negligible torsional resistance, the indicated torque is an accurate measure of test bearing torque. The torque is indicated directly on a Sanborn Model 311A transducer amplifier, and recorded simultaneously on a Honeywell recorder.

## 5. Inner Race Temperature Measurement

Test bearing inner race temperature is measured with a sub miniature size surface type temperature transducer which is 0.25 in. x 0.20 in. x 0.04 in. thick. It is a low mass, platinum sensor with 100 ohms resistance at the ice point. The sensor is located in a machined cavity directly beneath the test bearing inner race. Centrifugal forces due to rotation of the main shaft force the sensor against the bore of the inner race and provide an inner race temperature measurement. Output from the transducer is coupled from the rotating shaft to a stationary location by employing a rotary transformer. From the transformer the temperature is indicated directly on a Himmelstein meter located in the instrument console.

## 6. Drive System

The drive system consists of an air driven turbine, C, located approximately at the mid length of the main shaft, B. Air is supplied to the turbine by an auxiliary compressor via a nozzle ring, D. To obtain maximum speed, which is approximately 60,000 rpm, approximately 125 scfm of air at 100 psig is needed. Main shaft speed is monitored with an electronic tachometer mounted in the instrument console. Input to the tachometer is from a magnetic pickup whose interrupted signal is provided by 6 recesses located at the bottom most section of the main shaft.

## 7. Test Bearings and Retainers

The basic ball bearing geometry, a 204 size bearing with a 20 mm bore, used to conduct the solid lubricated bearing tests is shown in Figure 4. This geometry does not contain bearing internal clearance information since this parameter was varied from test to test. All of the test

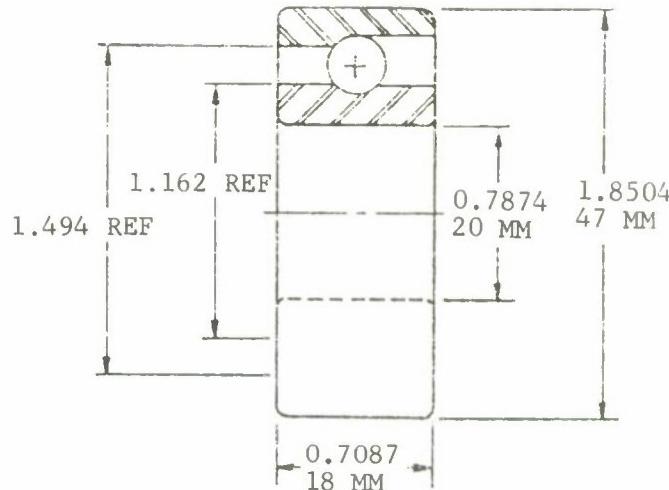


Figure 4. Basic 204 Size Test Bearing Geometry

bearings were fabricated from M-2 tool steel and had ABEC-5 precision ratings. Each bearing utilized eight balls which were 9/32 in. in diameter.

Some of the bearings utilized in these tests had inner races with machined grooves located around the circumference on the lands at either side of the ball groove. Figure 5 shows a detailed drawing of the grooves. Two different groove depths, 1 and 3 mils, were utilized. The intent of the grooves was to pump cooling air into the bearing by virtue of self-rotation of the inner race during operation.

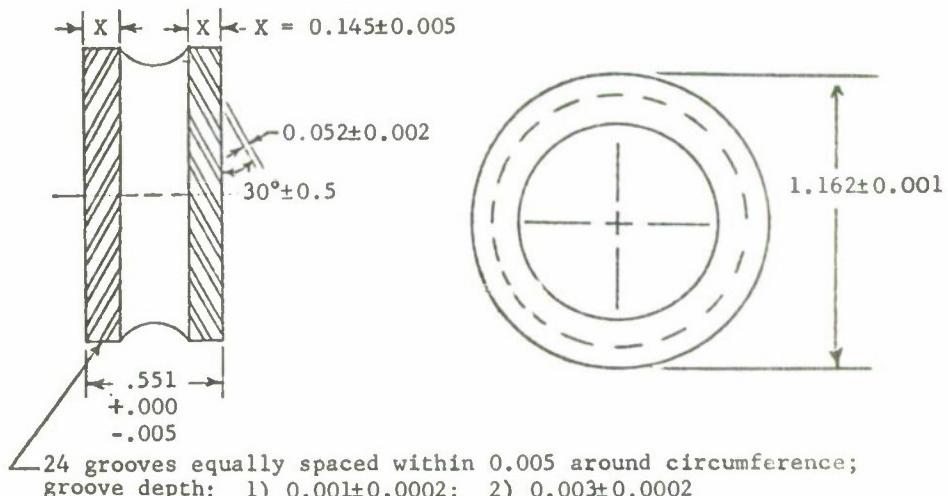


Figure 5. Detailed Drawing of Grooved Bearing

The cages used with the above described bearings were developed by Westinghouse Research Laboratories (Ref 1 & 2). They were comprised of a self-lubricating composite contained within a 303 stainless steel, reinforcing shroud assembly. Two different self-lubricating composite materials were utilized. One was a silver amalgam matrix in which was distributed a mixture of  $\text{MoSe}_2$  and PTFE (Teflon) particles. Its theoretical volume-percent composition is: 70 AgHg-20 WTE-10  $\text{MoSe}_2$ . The Teflon component of this composite material is designated WTE (waxy Teflon) because it has been chemically modified to exhibit a sharp melting point at approximately 590°F and, upon resolidification, has a waxy appearance. The second composite material was also an amalgam with the following theoretical weight-percent composition: 80WSe<sub>2</sub> - 20 GaIn. Further details on these materials, which in later sections will be referred to as AgHg and WGI, can be found in Ref 1. The basic geometry of the solid lubricant composite plus metal shroud (retainer) is shown in Figure 6.

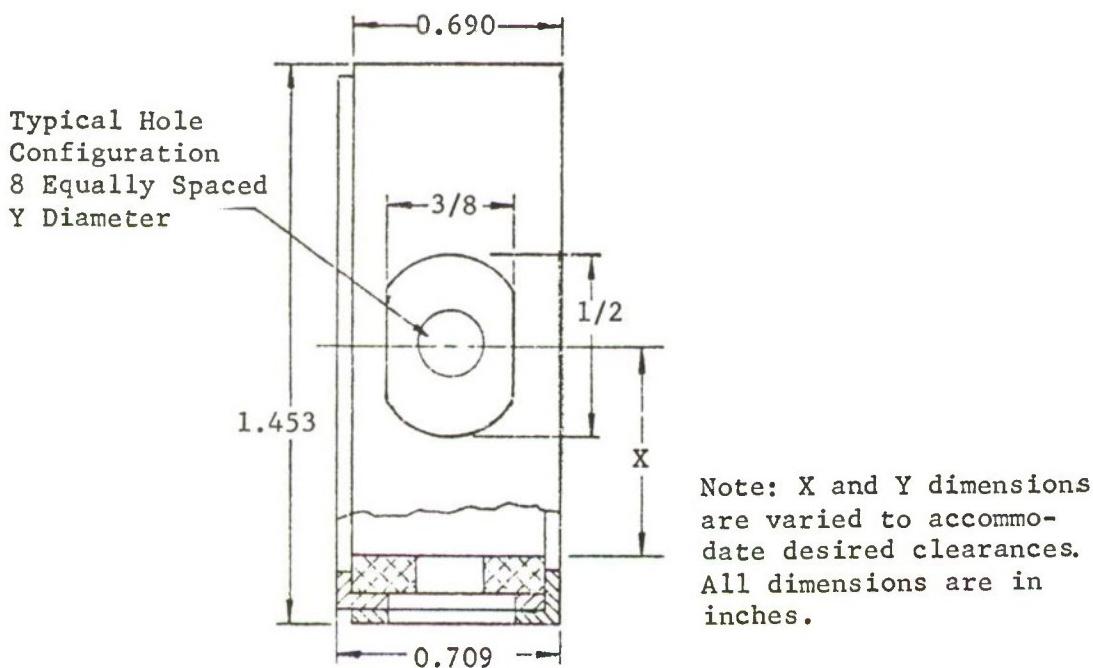


Figure 6. Solid Lubricant Retainer Geometry



Figure 7. Photograph of Grooved Bearing

The retainer inside diameter and ball hole diameters are not indicated on this drawing because they were varied from test to test in order to get the desired retainer-bearing inner race and ball hole clearances. A photograph of a new, unused bearing (with grooves) and retainer is presented in Figure 7.

## TEST PROCEDURE

The test procedure used to conduct the solid lubricated bearing tests is described below.

### 1. Test Bearing Preparation

The test bearings were prepared in the following manner prior to installation in the test rig:

- a. Initial degreasing in Stoddard solvent.
- b. Rinse in fresh methylene chloride.
- c. Final wash in ethyl alcohol.
- d. Composite cage installation and storage in dessicator until ready

for test.

### 2. Test Start-up and Running Sequence

- a. After the bearing is assembled in the test rig, rotation is initiated with full axial load and zero radial load.
- b. Bearing speed is then increased to the desired value and the radial load, if any, is applied.
- c. The bearing is then allowed to operate at a given speed and load condition until a stabilized bearing temperature is obtained. While waiting for the temperature to stabilize, intermediate values of torque and temperature were recorded every 15 minutes. Stabilized temperature operation was considered to have been reached when any two successive recordings of torque and temperature were identical. In general, stabilized temperatures were usually reached within 30 minutes after application of a new load or speed condition.

For the first several tests both inner and outer race temperatures were measured. However, it was found that oil used to cool and lubricate the rotary transformer (which is used in conjunction with the inner race temperature sensor) was leaking into the test chamber and contaminating the test bearing. Attempts were made to correct the problem but none of them were entirely satisfactory. As a result, it was decided to eliminate the transformer and discontinue the inner race temperature measurement.

d. The sequence of running each test was to cover the entire speed range at each level of thrust load to be investigated. No radial load was applied for these tests. Once the range of thrust loads was covered, radial load was applied at a given level of thrust load and then successively increased until the entire range of radial load was covered.

## DISCUSSION OF RESULTS

### 1. General Comments

An overall summary of the test series conducted is presented in Table I. Series 20 through 24 are not included as they were conducted in a different manner. Several facts are readily apparent. Of the 19 test series conducted only 4 were not stopped prematurely for one reason or another. All of these had bearings with silver-mercury-molybdenum diselenide retainers. It should be noted that bearing cage unbalance problems played a predominant role in contributing to curtailed test series runs. Figures 8 and 9 show the effect of the unbalance on bearing operation. As can be seen, rub on both the retainer I.D. and O.D. resulted. This unbalance prevented the acquisition of sufficient data on both grooved and ungrooved bearings to make a valid assessment of their effectiveness. The effects of such variables as speed, radial load and axial load upon bearing heat generation and operating temperature were consistent, however, and similar to those observed by other investigators (see Refs. 1-6).

### 2. Bearing Retainer Material Effects

Figures 10 through 14 present the test data by series test number. These included measured bearing outer and inner race temperature data and bearing torque. The average data values for each test series are shown as well as the average value for all test series. In general, both inner and outer race temperatures were lower for bearings with AgHg cages than those with WGI retainers. A similar trend for bearing torque values is not nearly as evident from figure 14.

TABLE I  
TEST SERIES SUMMARY

TEST SERIES NO.	RETAINER MATERIAL	BEARING INTERNAL CLEARANCE INCHES	BALL HOLE CLEARANCE INCHES	CAGE LAND CLEARANCE INCHES	BEARING GROOVE DEPTH INCHES	TOTAL OPERATING TIME HOURS	REMARKS
1	AgHg	0.005	0.010	0.015	0.003	7.1	ball-shroud contact, unbalance, oil
2	WGI	0.005	0.010	0.015	NONE	20.5	ball shroud contact,oil
3	AgHg	0.005	0.010	0.015	NONE	37.8	test series completed w/o problems
4	AgHg	0.005	0.010	0.015	NONE	20.7	to check O.R. temp, torque w/o IR sensor
5	AgHg	0.005	0.010	0.015	0.003	34.2	test series completed, oil
6	WGI	0.010	0.017	0.022	NONE	7.0	unbalance
7	WGI	0.010	0.017	0.022	NONE	2.5	unbalance
8	WGI	0.010	0.017	0.022	NONE	1.8	unbalance
9	WGI	0.010	0.017	0.022	NONE	2.3	ball shroud contact
10	WGI	0.010	0.017	0.022	NONE	2.5	unbalance
11	AgHg	0.010	0.017	0.022	NONE	34.4	Test series completed w/o problems
12	AgHg	0.010	0.017	0.022	0.001	2.0	unbalance
13	AgHg	0.010	0.017	0.022	0.001	1.5	unbalance
14	AgHg	0.010	0.017	0.036	0.001	19.0	
15	WGI	0.005	0.017	0.022	0.003	6.9	unbalance
16	WGI	0.005	0.017	0.022	0.003	0.0	defective bearing
17	AgHg	0.010	0.010	0.015	0.001	3.7	unbalance
18	WGI	0.005	0.010	0.015	NONE	9.2	unbalance
19	WGI	0.005	0.010	0.015	NONE	2.9	unbalance

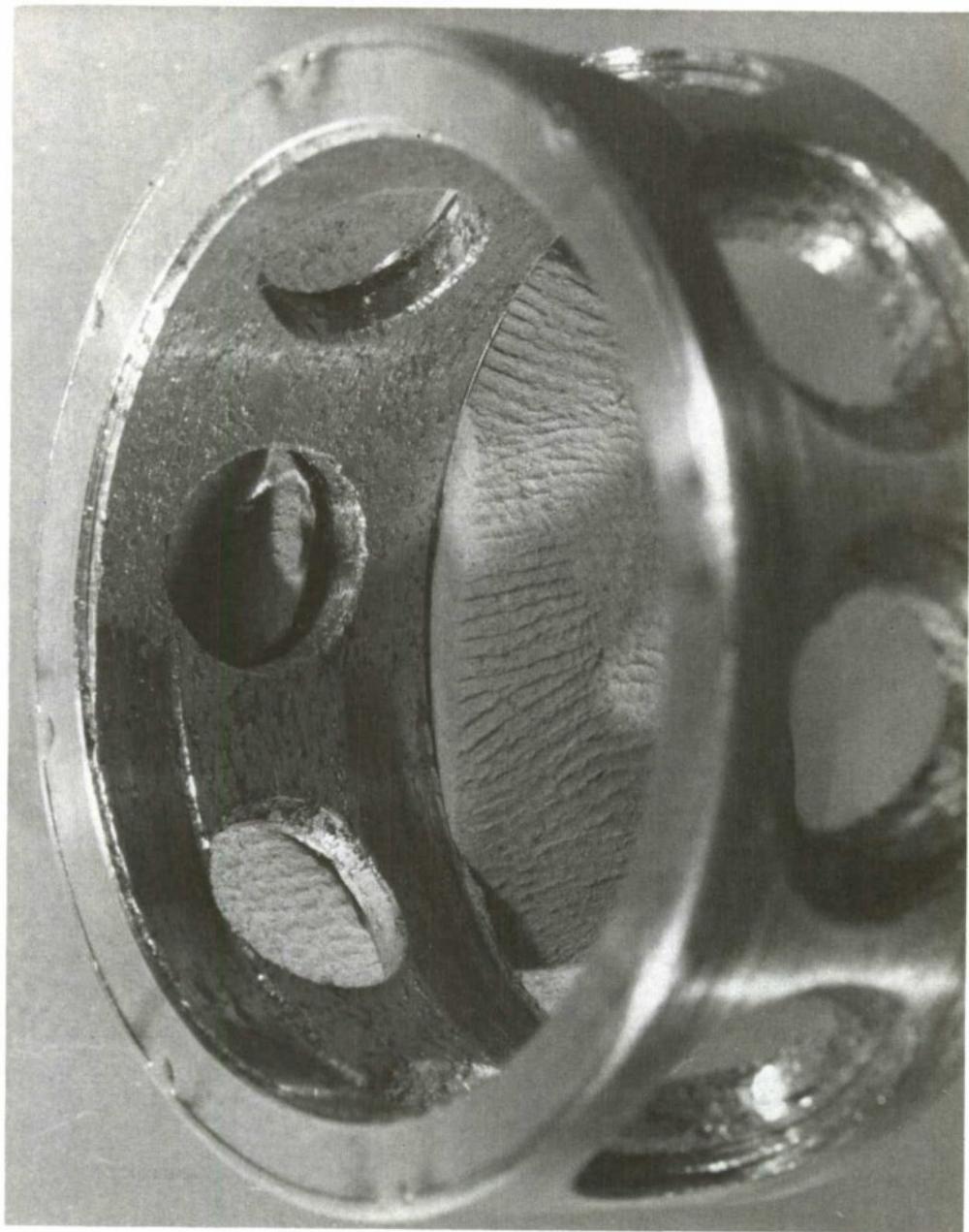
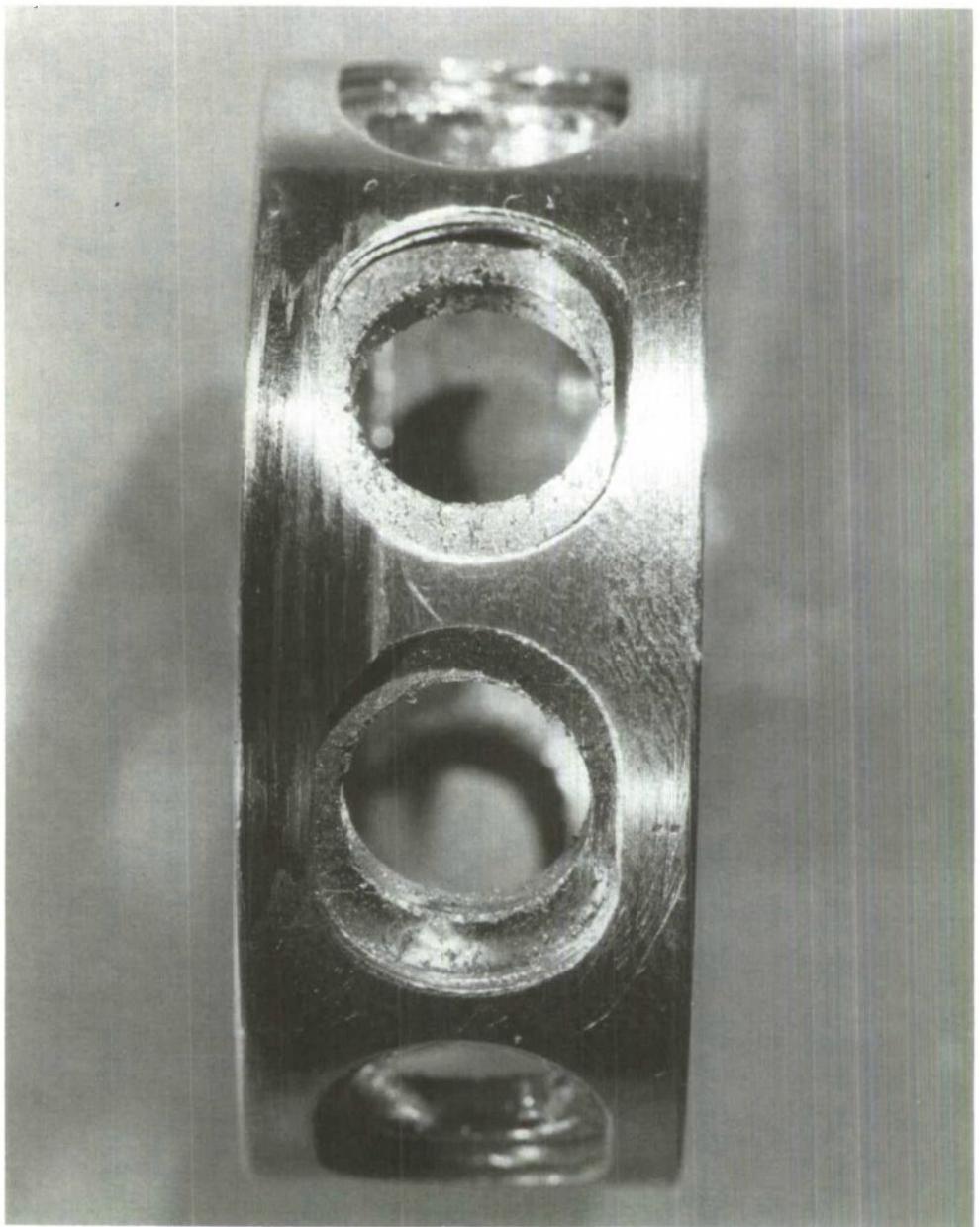


Figure 8. Effects of Cage Imbalance on Retainer Wear - Cage I.D.

Figure 9. Effects of Cage Imbalance on Retainer Wear - Cage O.D.



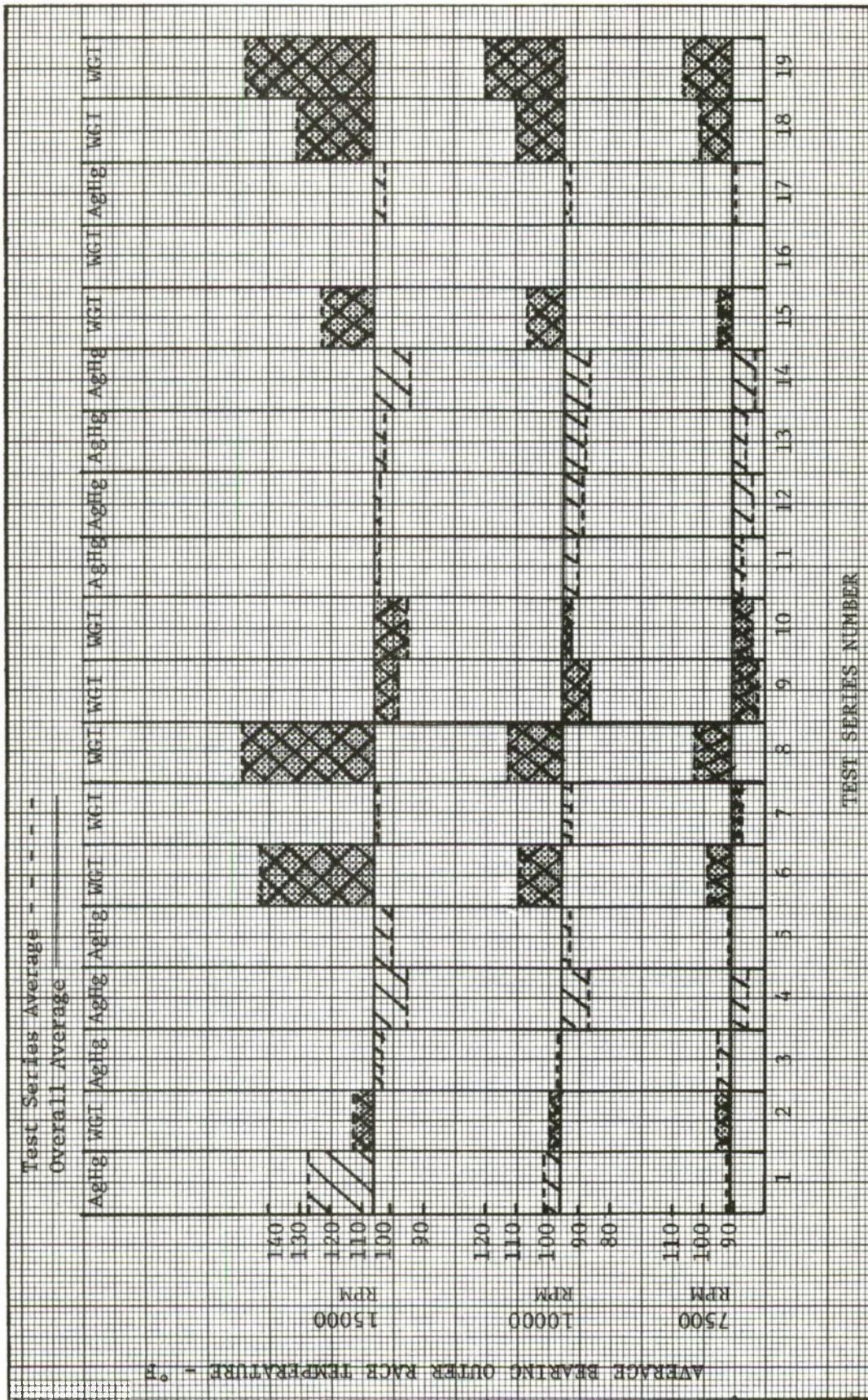
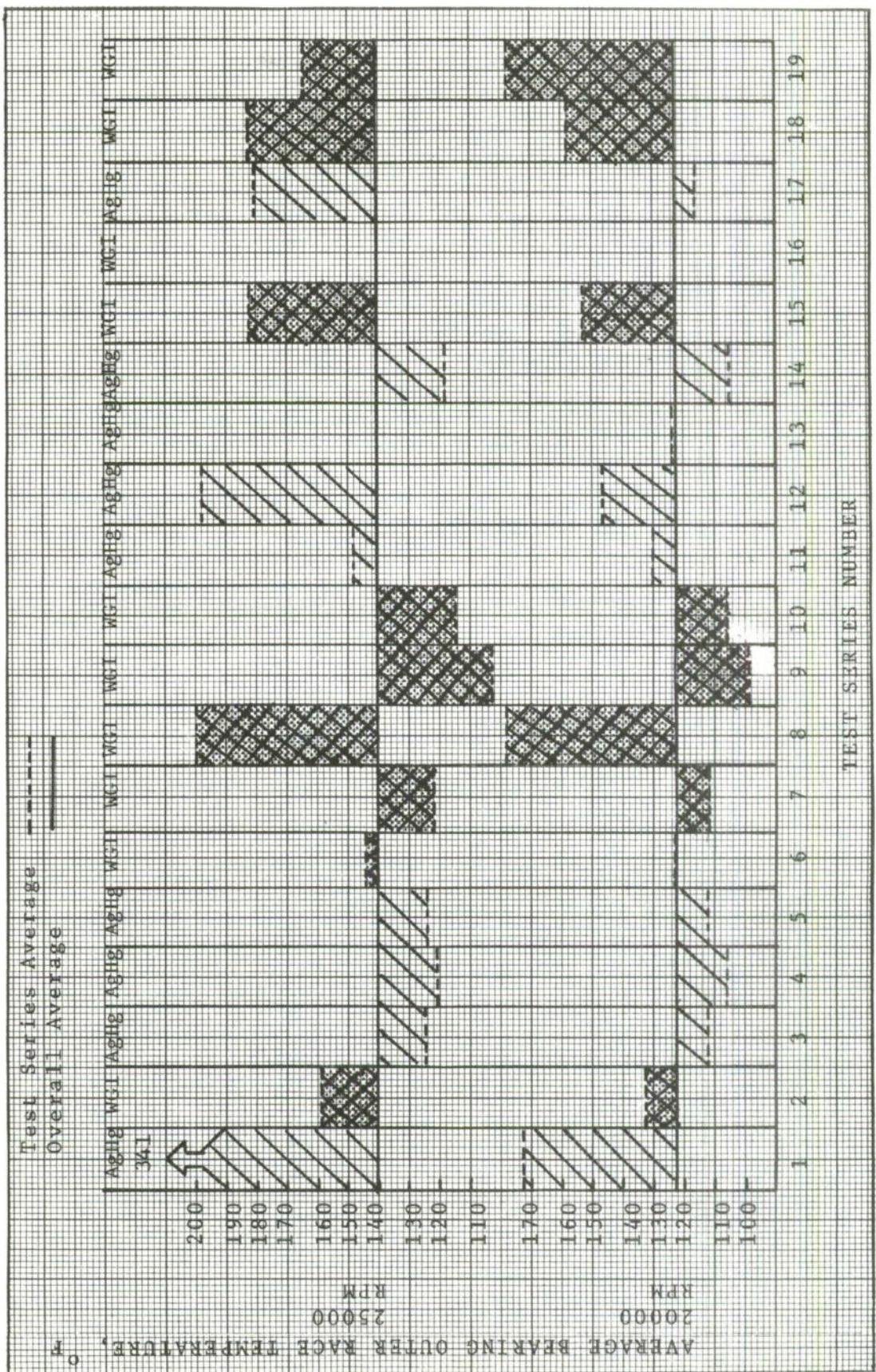


Figure 10. Avg. Bearing Outer Race Temperature at Constant Speed by Test Series Number - 7500, 10,000, and 15,000 RPM



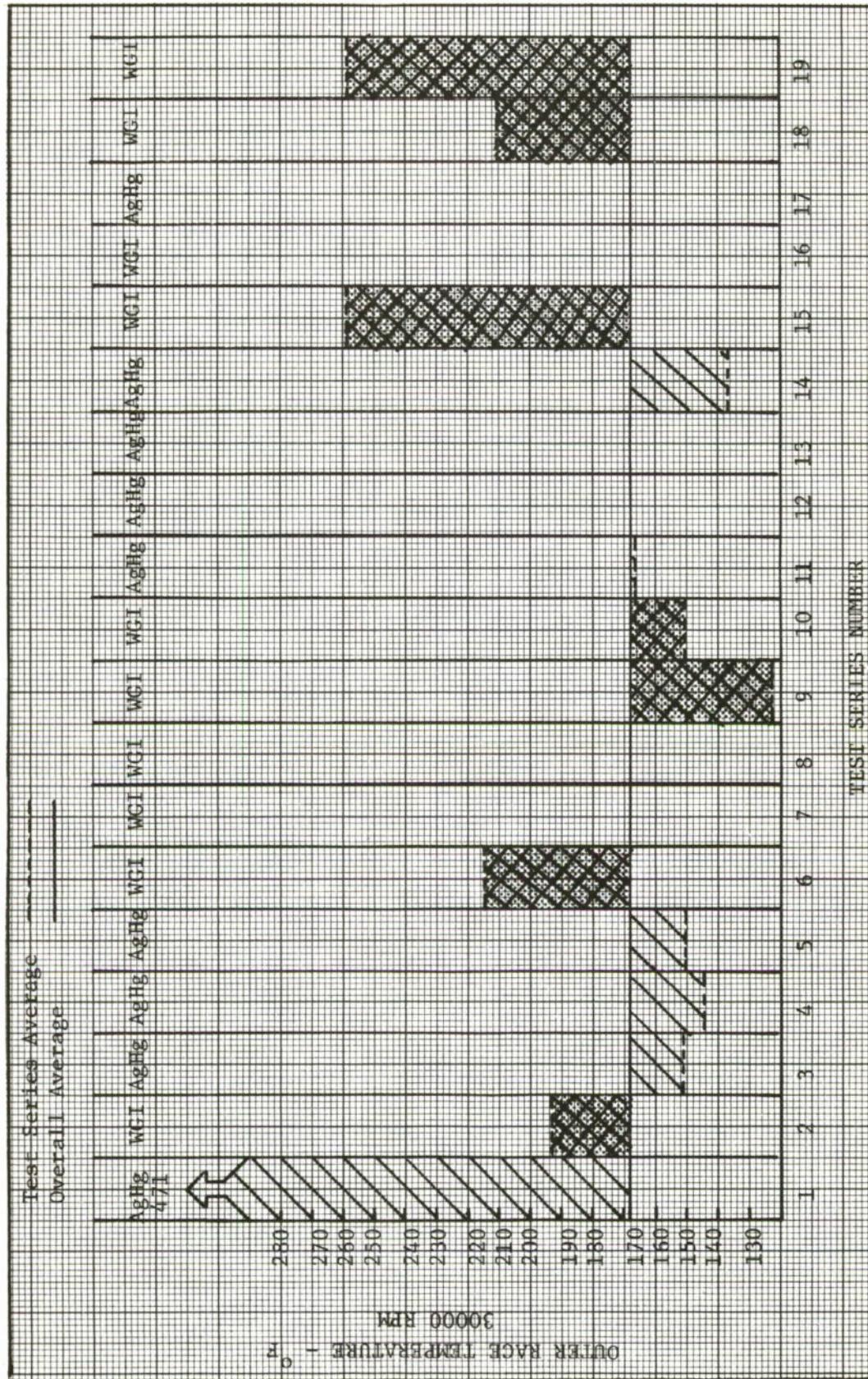


Figure 12. Avg. Bearing Outer Race Temperature at Constant Speed by Test Series Number - 30,000 RPM

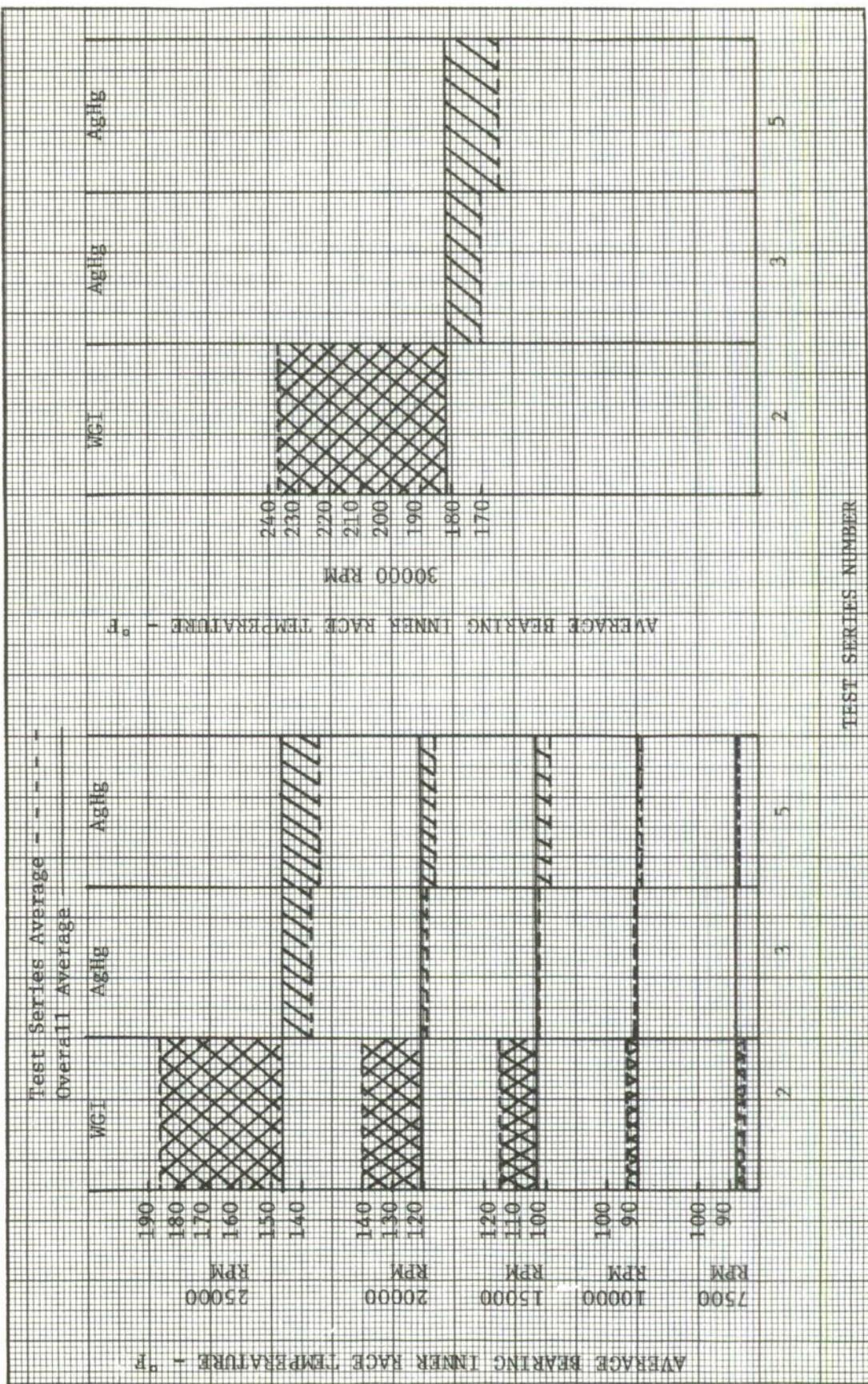


Figure 13. Avg. Bearing Inner Race Temperature at Constant Speed by Test Series Number - 7500, 10,000, 15,000, 20,000, and 25,000 RPM

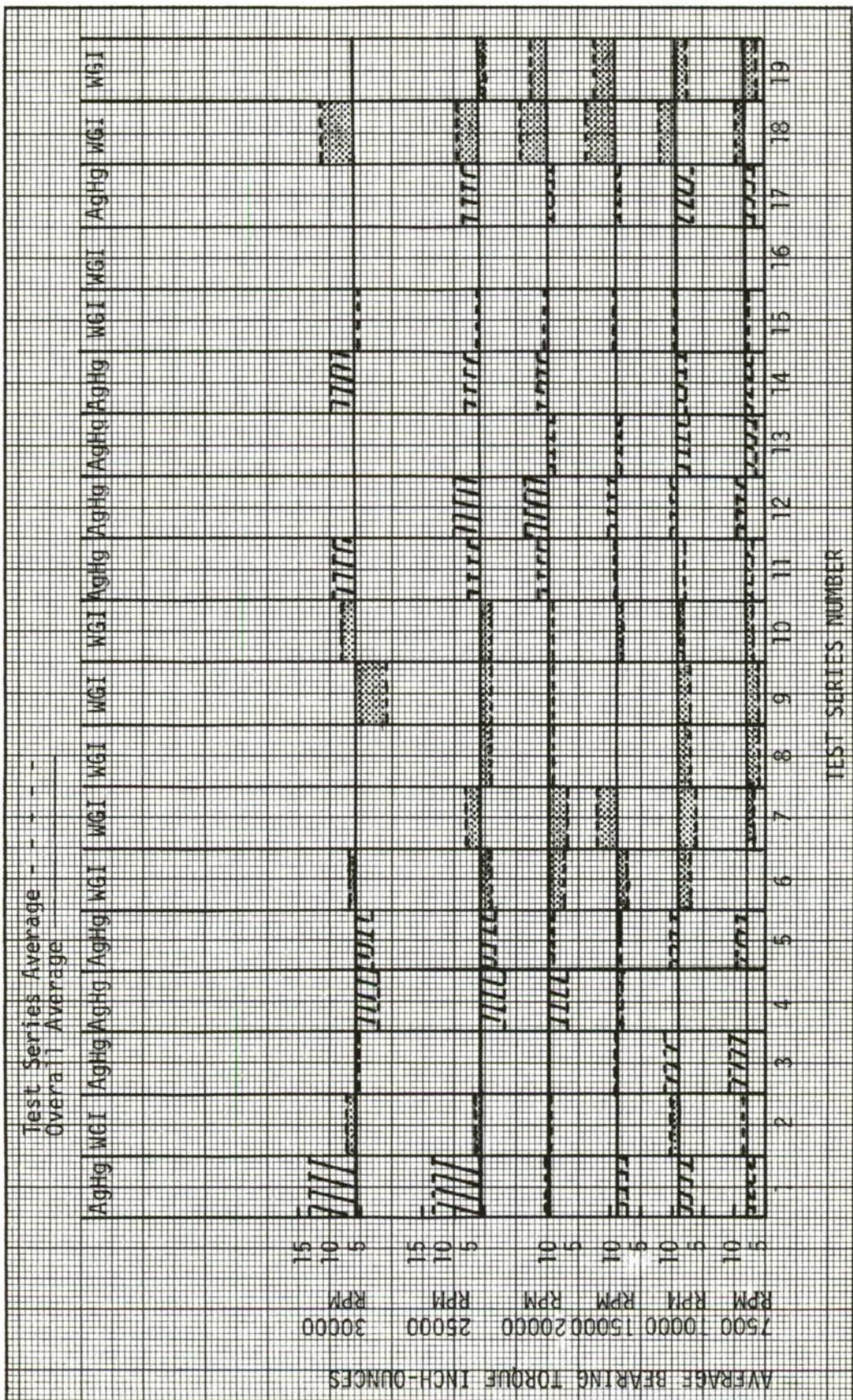


Figure 14. Avg. Bearing Torque at Constant Speed by Test Series  
Number - 7500, 10,000, 15,000, 20,000, 25,000, and 30,000 RPM

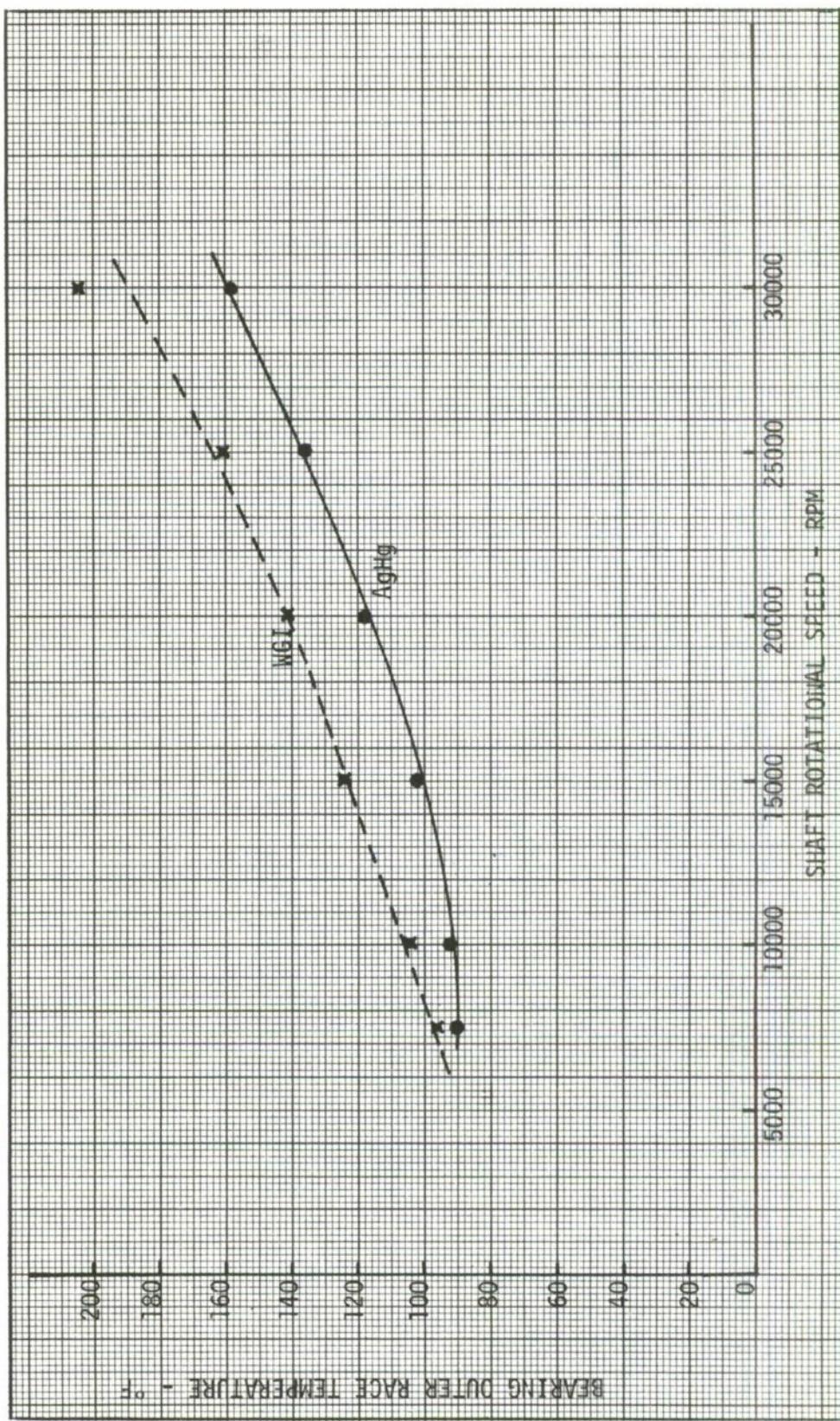


Figure 15. Variation of Avg. Bearing Outer Race Temperature with Shaft Rotational Speed for Bearings with WGI and AgHg Retainers

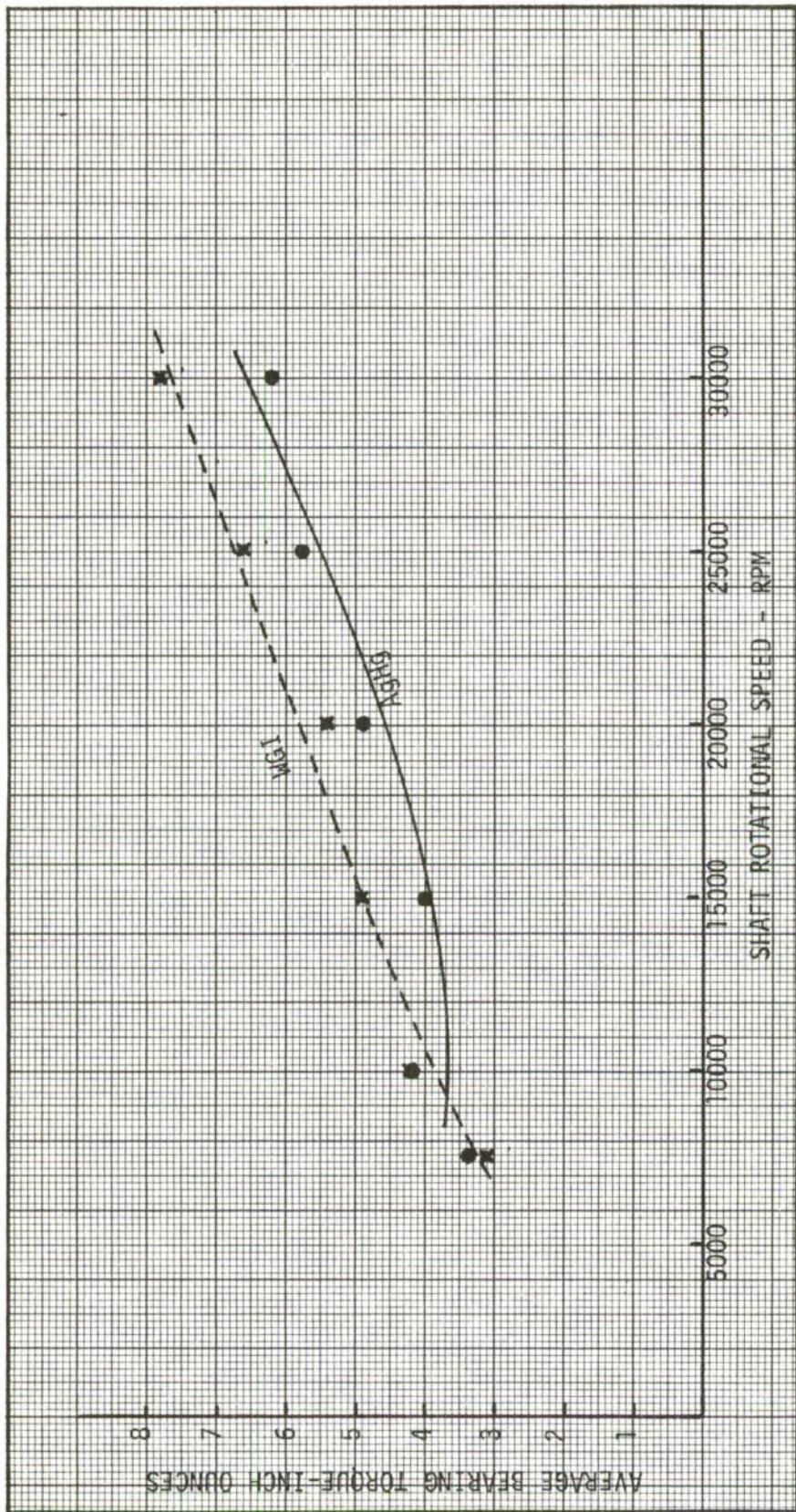


Figure 16. Variation of Avg. Bearing Torque with Shaft Rotational Speed  
for Bearings with WGI and AgHg Retainers

However, when average bearing outer race temperatures and torque values are related as a function of shaft rotational speed and bearing retainer cage material, a distinct difference is apparent. These relationships are shown in Figures 15 and 16. In both cases the AgHg composites cages operated cooler and with less torque at any given speed. The differences below 10,000 RPM are probably indistinguishable and may be considered the same for both materials.

### 3. Bearing Load Effects

It was not anticipated that bearing loads would have an overriding effect on temperature levels or torque values. This was verified as shown in Figures 17 through 20. Here the effects of both radial and axial loads upon average bearing outer race temperature and torque for both materials are presented. Both materials are included since the same results were seen for both materials. In the radial load range of 0-75 pounds and the axial load range of 50 to 150 pounds the load effects were minimal.

### 4. Speed Effects

The overriding parameter affecting bearing operating temperature and torque was shaft rotational speed. For this reason it was necessary to include speed as a separate variable for all of the relationships shown. This is directly translatable into an effect on bearing heat generation rate as well, since, that too, is a function of speed and torque. The effect of speed on bearing outer race temperature and torque is shown in figure 21 and 22. These parameters increase significantly with increasing shaft rotational speed.

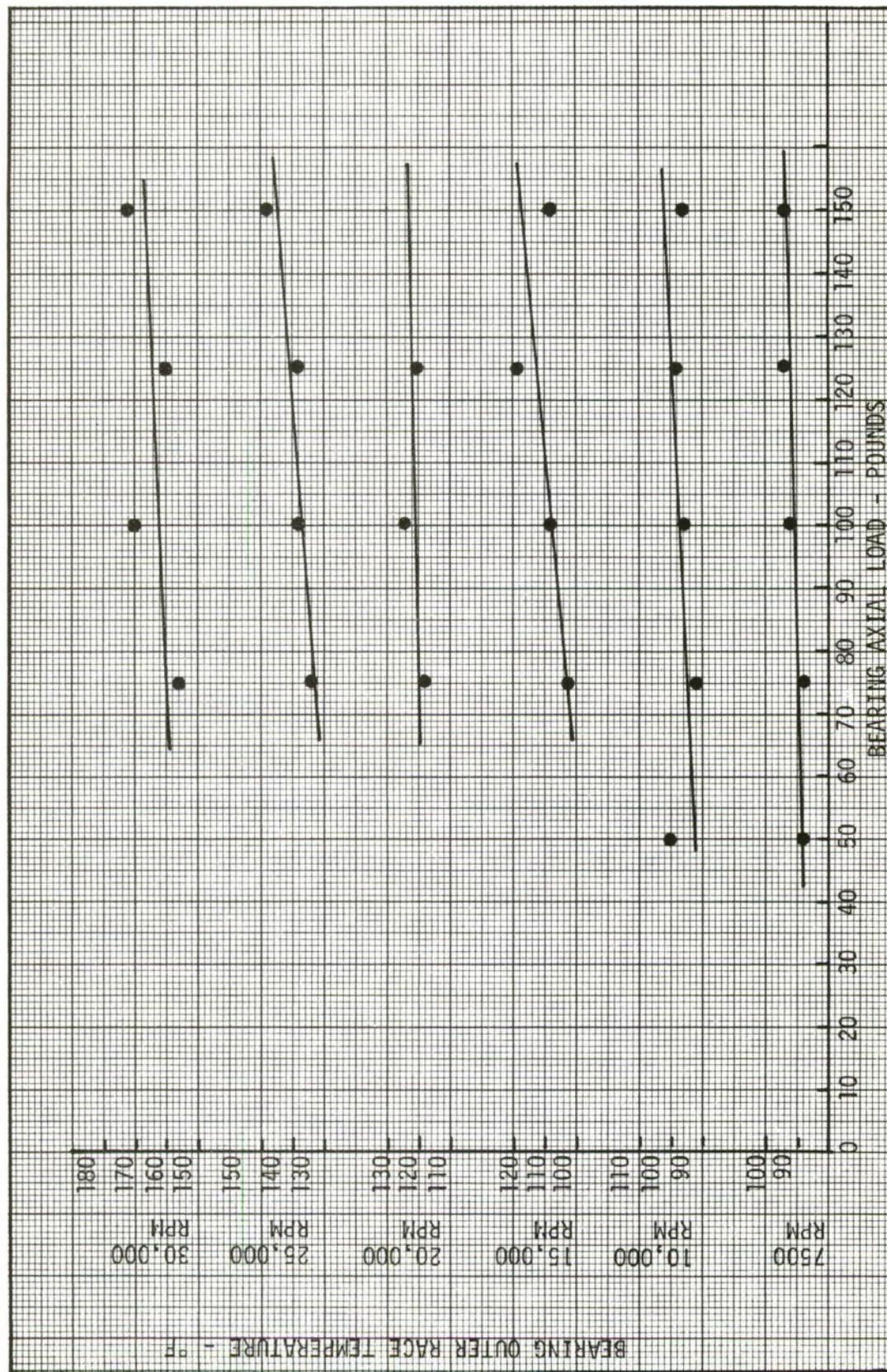


Figure 17. Variation of Avg. Bearing Outer Race Temperature with Bearing Axial Load at Constant Speed

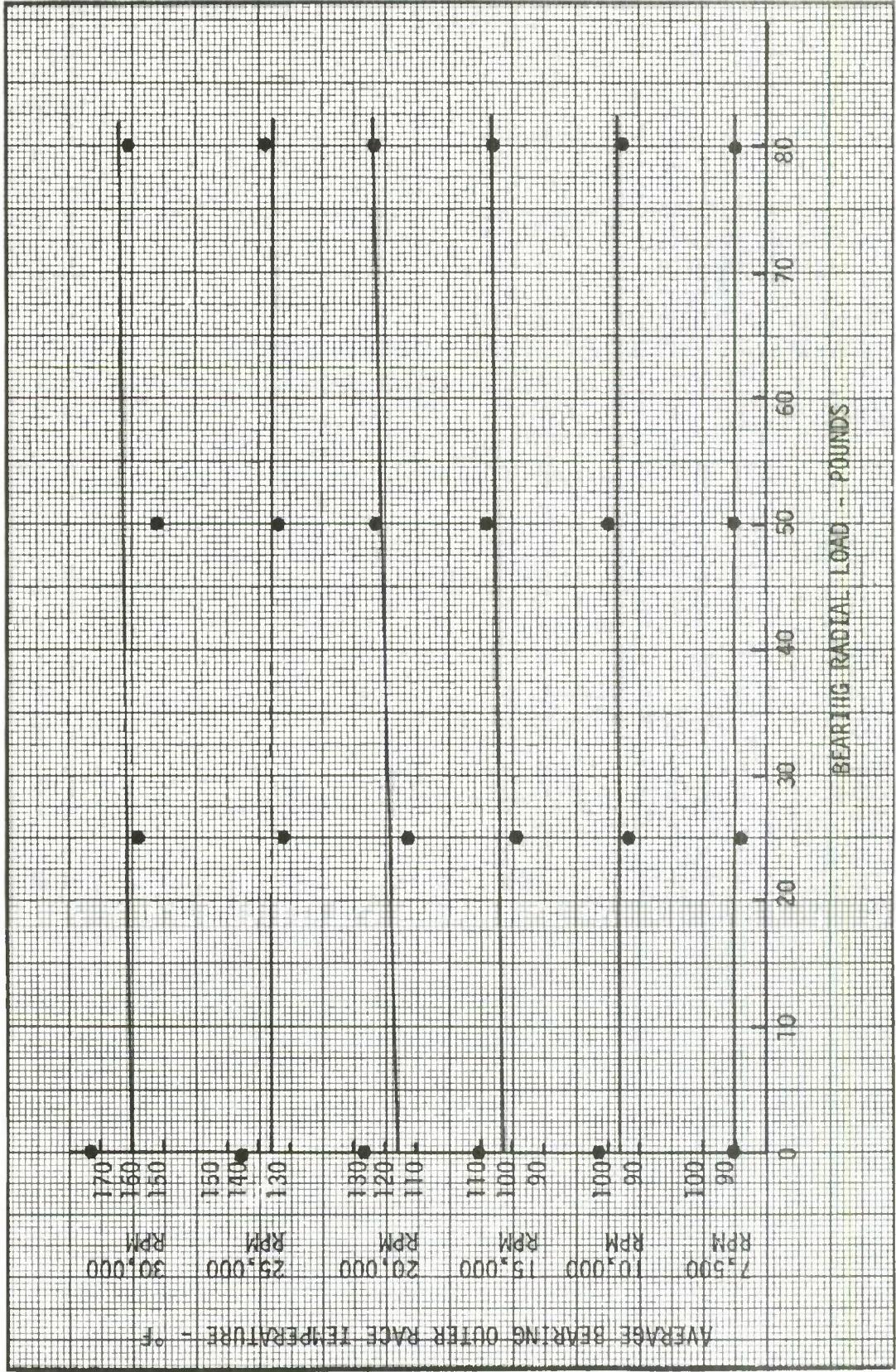


Figure 18. Variation of Avg. Bearing Outer Race Temperature with Bearing Radial Load at Constant Speed

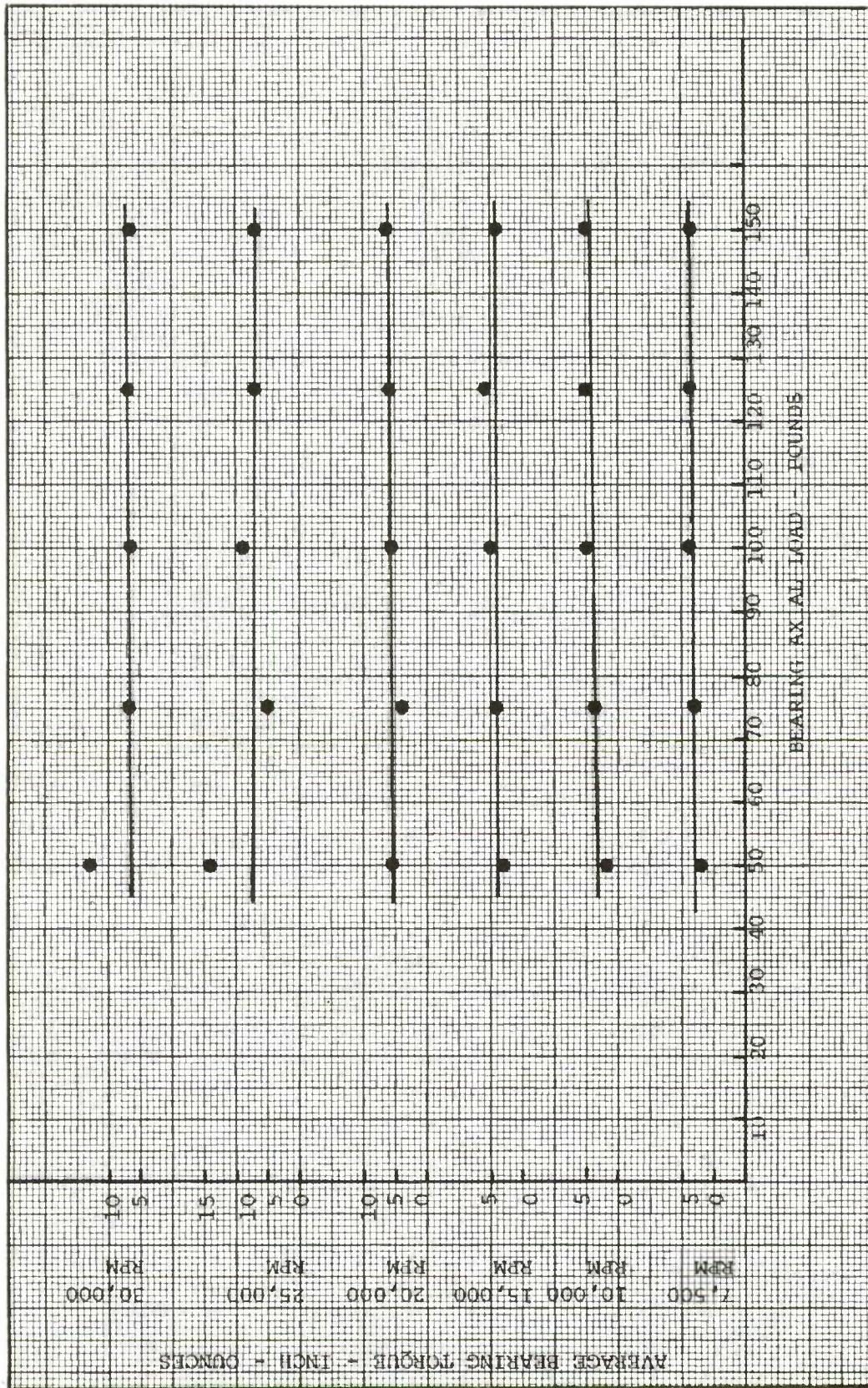


Figure 19. Variation of Avg. Bearing Torque with Bearing Axial Load at Constant Speed

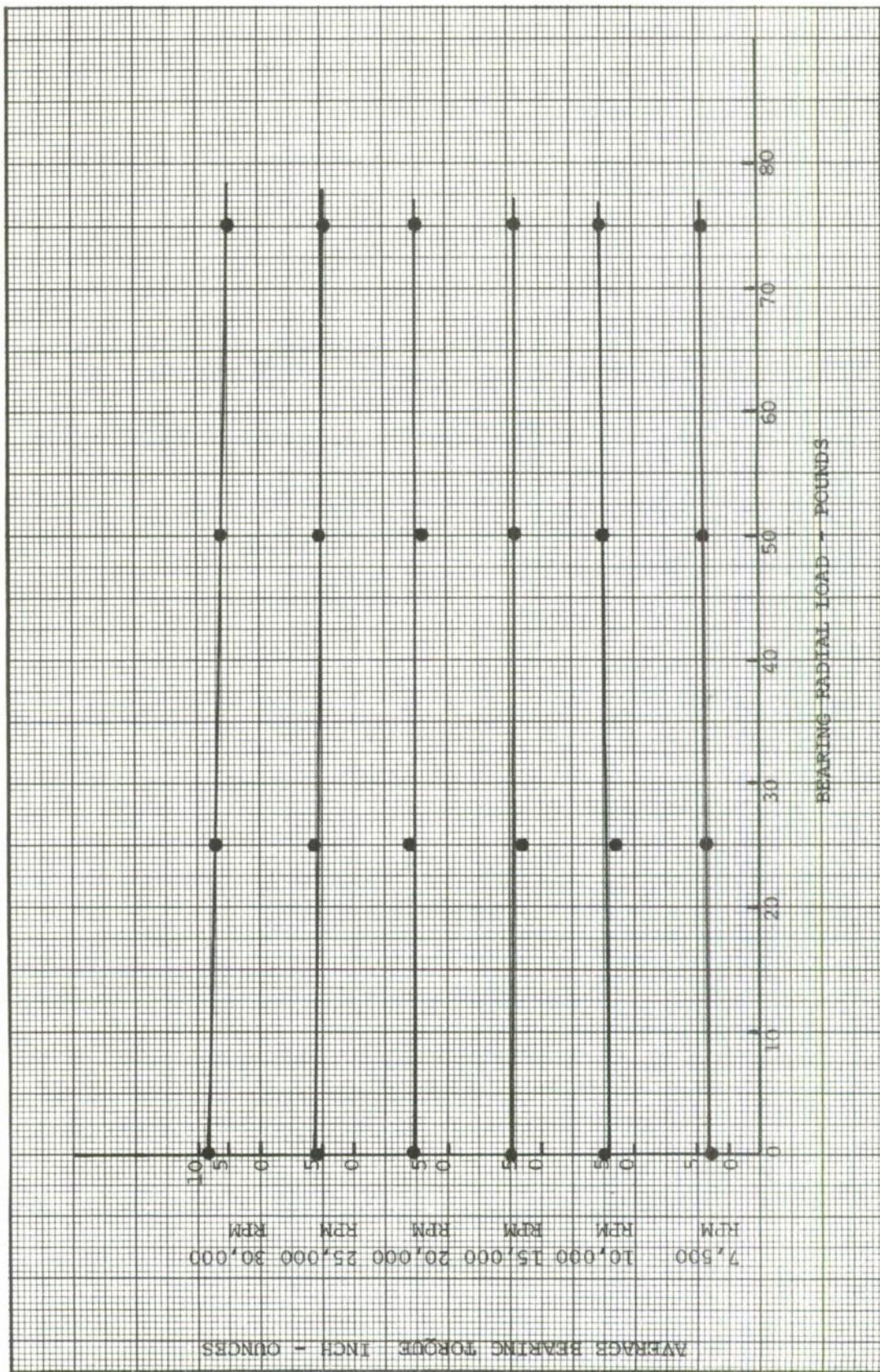


Figure 20. Variation of Average Bearing Torque with Bearing Radial Load at Constant Speed

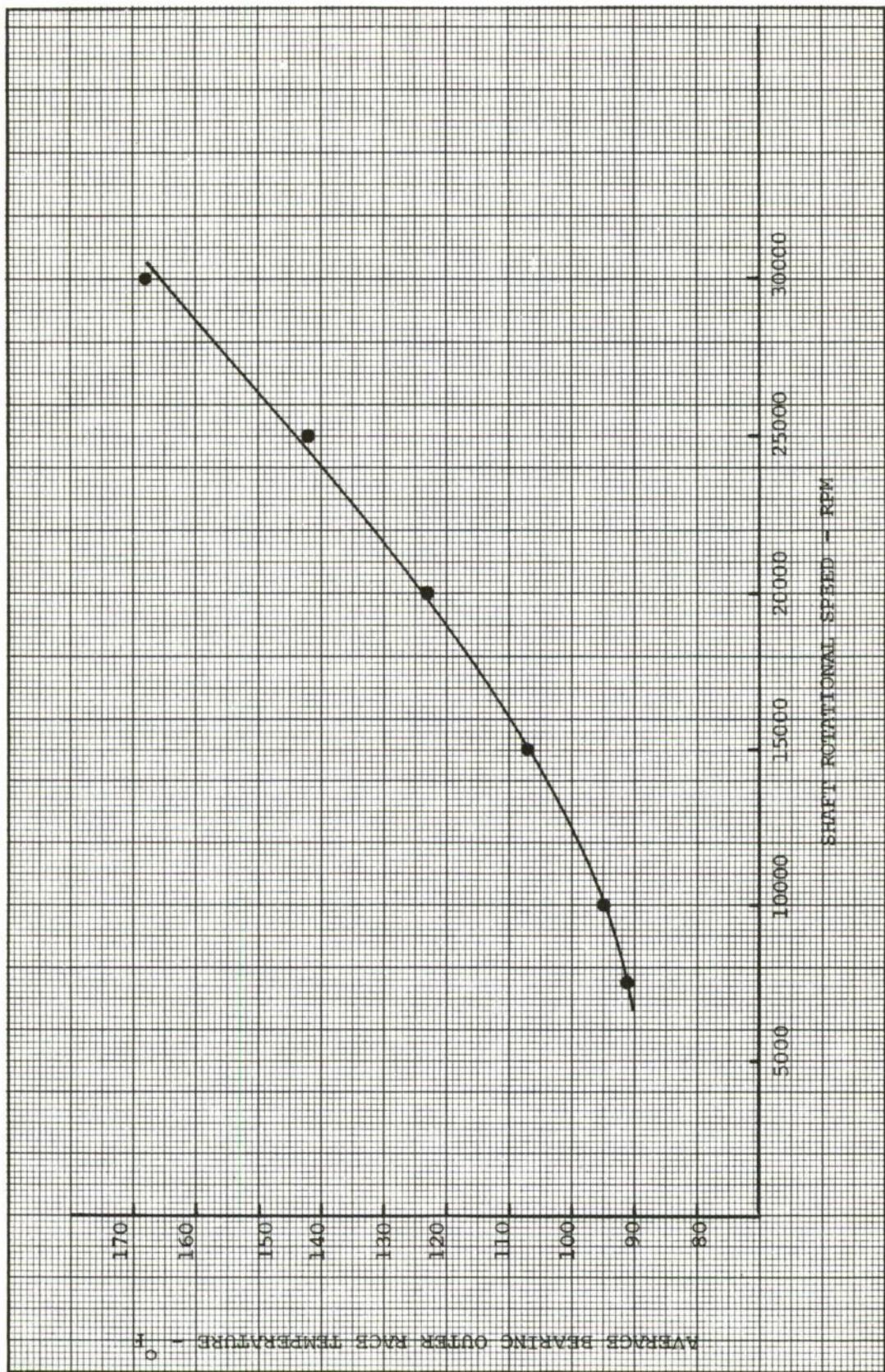


Figure 21. Variation of Average Bearing Outer Race Temperature with Speed

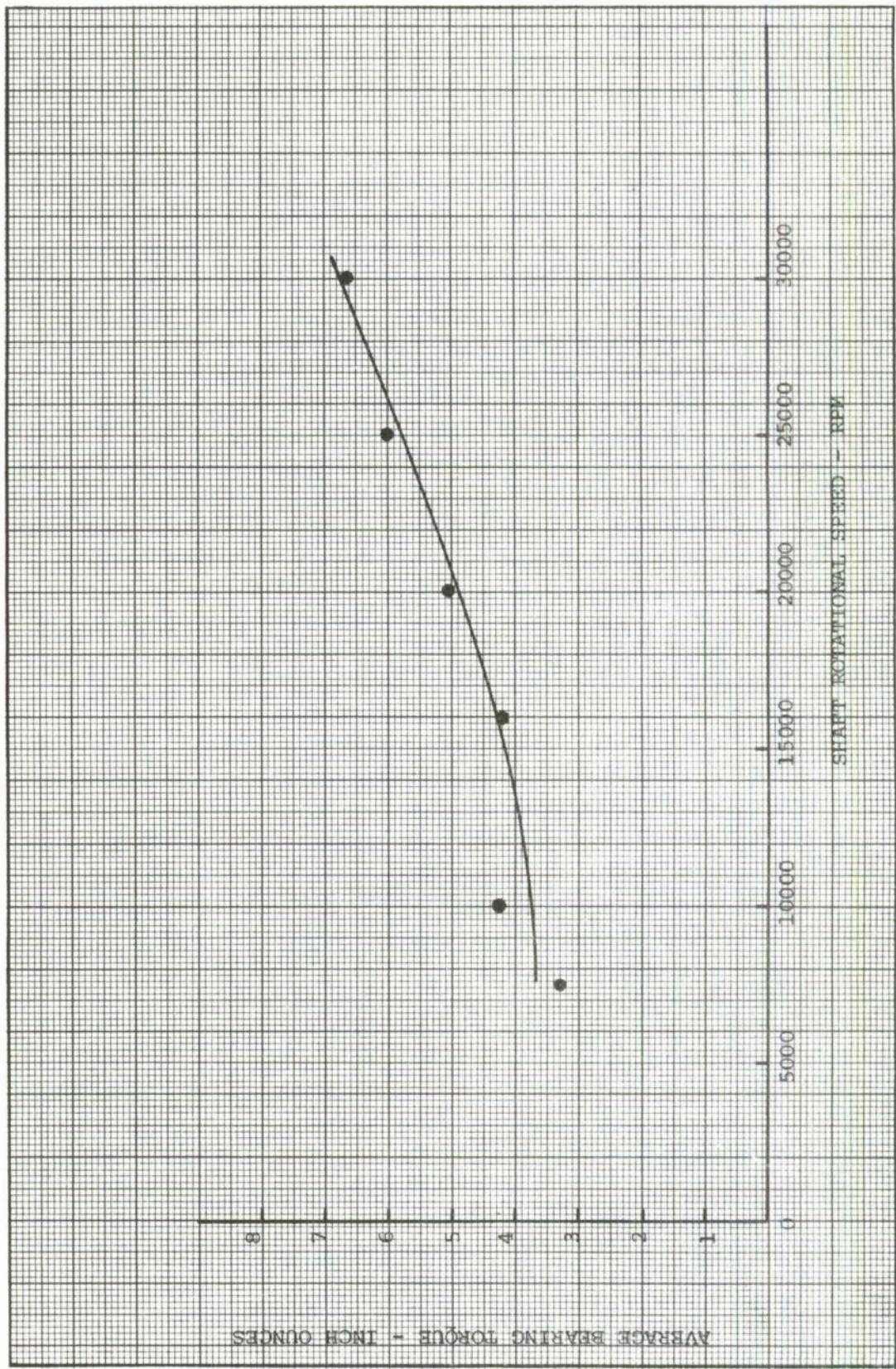


Figure 22. Variation of Average Bearing Torque with Speed

## 5. Bearing Heat Generation

Translation of the data into bearing heat generation information is based on the equation relating heat generation as a function of speed and torque (Ref 4). Calculated results are shown in Table II. Heat generation as a function of speed is shown in Figures 23 through 26 for each of the 19 series of tests. An attempt was made to include bearing geometry and bearing cage material as variables. All figures show the average heat generation value for the 19 test series, as well. This was used as a reference to make comparisons of the data easier.

Since no grooved bearing data for the WGI retainers is available, no comparisons were made. From the data accumulated, it appears however, that the larger clearance bearings, in general, ran cooler than the smaller clearance ones when equipped with WGI cages.

The data on bearings using AgHg retainers was somewhat the opposite. In general, small clearance bearings ran cooler than the larger clearance ones. There was no consistency with respect to the presence of grooves or groove depth. Some performed better and some performed worse than ungrooved bearings. This was true for both groove depths of 0.001 and 0.003 inches. For this reason it is not possible to determine if grooving the bearings was beneficial, detrimental or had any effect at all on bearing heat generation or operating temperature.

## 6. 40,000 RPM tests

It was hoped from this test series that at a high operating speed the effects of bearing grooves would be more apparent. Since operating experience at this speed was almost non-existent, it was decided to eliminate varying axial and radial load conditions and to monitor bearing performance in a duration type test. It was intended to run comparable tests on bearings

with both retainer types with grooved and ungrooved bearings. Due to bearing cage unbalance problems, however, the only successful runs were made with ungrooved bearings with AgHg retainers. Tests 21, 22 and 23 were all curtailed after about 15 minutes operation due to severe cage unbalance situations.

Figures 27 through 29 show the variation of bearing outer race temperature, torque and heat generation with time for test no. 20. Bearing temperature although fluctuating showed a gradual increase with time. The fourteen and a half hour run is the longest time a solid lubricated bearing has operated at 40,000 RPM. The torque and heat generation curves have the same shape since one is calculated as a direct function of the other. After a fluctuating start both remained steady for a number of hours and then increased steadily until the end of the test.

Figure 30 shows similar data for test number 24. The bearing outer race temperature rose sharply at the start, fell somewhat, then increased gradually with time until the test was ended. Sharply rising temperatures at the end along with a very high torque reading indicated a bearing problem. Bearing torque and heat generation rose slightly to a constant level and remained there for a few hours. They then dropped steadily and somewhat sharply with time until the sudden increase occurred. Torque levels ran throughout the test at a level significantly higher than those in test 20. The only difference between tests number 20 and 24 is that bearing and cage clearances were small in test 20 and larger in 24. Why torque increased in one case and decreased in the other is not known nor can it be conclusively stated that the torque level variation was attributed to the variations in bearing geometry since unbalance problems were encountered.

TABLE II  
BEARING HEAT GENERATION CALCULATIONS

The basic heat generation equation used was  $Q = 0.0404\tau \times N$  (Ref 4) where  $Q$  is the heat generation rate in BTU/hr,  $\tau$  is bearing torque in inch pounds and  $N$  is speed in RPM. Using average torque values for each speed condition heat generation rates were calculated for the different test series.

Test Series No.	Avg $\tau$	in-Oz	in-Oz	in-Oz	in-Oz	in-Oz	in-Oz	Mat'l	Remarks
	N	7500	10000	15000	20000	25000	30000	Clearances Mils	Grooves Mils
	Q	=18.9375 $\tau$	=25.25 $\tau$	=37.875 $\tau$	=50.50 $\tau$	=63.125 $\tau$	=75.75 $\tau$		
1	37.875	50.500	94.688	284.315	852.188	1022.625	A9Hg	5-10-15	3
2	70.258	137.865	151.500	239.875	428.619	584.033	WGI	5-10-15	NONE
3	104.156	154.278	175.740	246.945	371.806	421.928	A9Hg	5-10-15	NONE
4	55.676	104.283	109.080	107.565	126.250	199.223	A9Hg	5-10-15	NONE
5	80.484	132.058	126.881	203.010	239.244	267.398	A9Hg	5-10-15	3
6	56.813	54.793	88.249	126.250	284.063	530.250	WGI	10-17-22	NONE
7	37.875	25.250	265.125	101.000	536.563	-	WGI	10-17-22	NONE
8	18.938	50.500	151.500	202.000	252.500	-	WGI	10-17-22	NONE
9	18.938	50.500	151.500	202.000	252.500	75.750	WGI	10-17-22	NONE
10	37.875	75.750	113.625	202.000	252.500	643.875	WGI	10-17-22	NONE
11	37.118	71.963	174.983	316.635	463.969	703.718	A9Hg	10-17-22	NONE
12	75.750	126.250	189.375	429.250	631.250	-	A9Hg	10-17-22	1
13	18.938	50.500	113.625	202.000	-	-	A9Hg	10-17-22	1
14	35.603	69.438	160.969	315.025	493.006	752.198	A9Hg	10-17-36	3
15	50.563	109.333	176.876	269.165	389.481	416.625	WGI	5-17-22	3
16	-	-	-	-	-	-	WGI	5-17-22	3
17	28.406	37.875	113.625	202.000	552.344	-	A9Hg	10-10-15	1
18	75.750	167.408	317.393	467.125	599.688	862.035	WGI	5-10-15	NONE
19	18.938	50.500	265.125	378.750	315.625	-	WGI	5-10-15	NONE
Sm. C1 A9Hg	69.548	110.280	126.597	210.459	397.372	477.794	Avg A9Hg	5-10-15	
Lg. C1 A9Hg	41.852	79.538	159.738	315.878	529.408	727.958	Avg A9Hg	10-17-22,	36
TOTAL A9Hg	52.667	88.572	139.885	256.372	466.257	561.182	Avg A11	A9Hg	
Sm C1 WGI	54.982	118.591	244.673	361.917	447.977	723.034	Avg WGI	5-10-15	
Lg C1 WGI	34.088	51.359	154.000	166.650	315.625	416.625	Avg WGI	10-17-22	
TOTAL WGI	50.563	109.333	176.876	269.165	389.481	416.625	Avg WGI	5-17-22	
TOTAL ALL	47.775	84.391	163.326	249.751	414.212	539.972	Avg A11	Test Series	

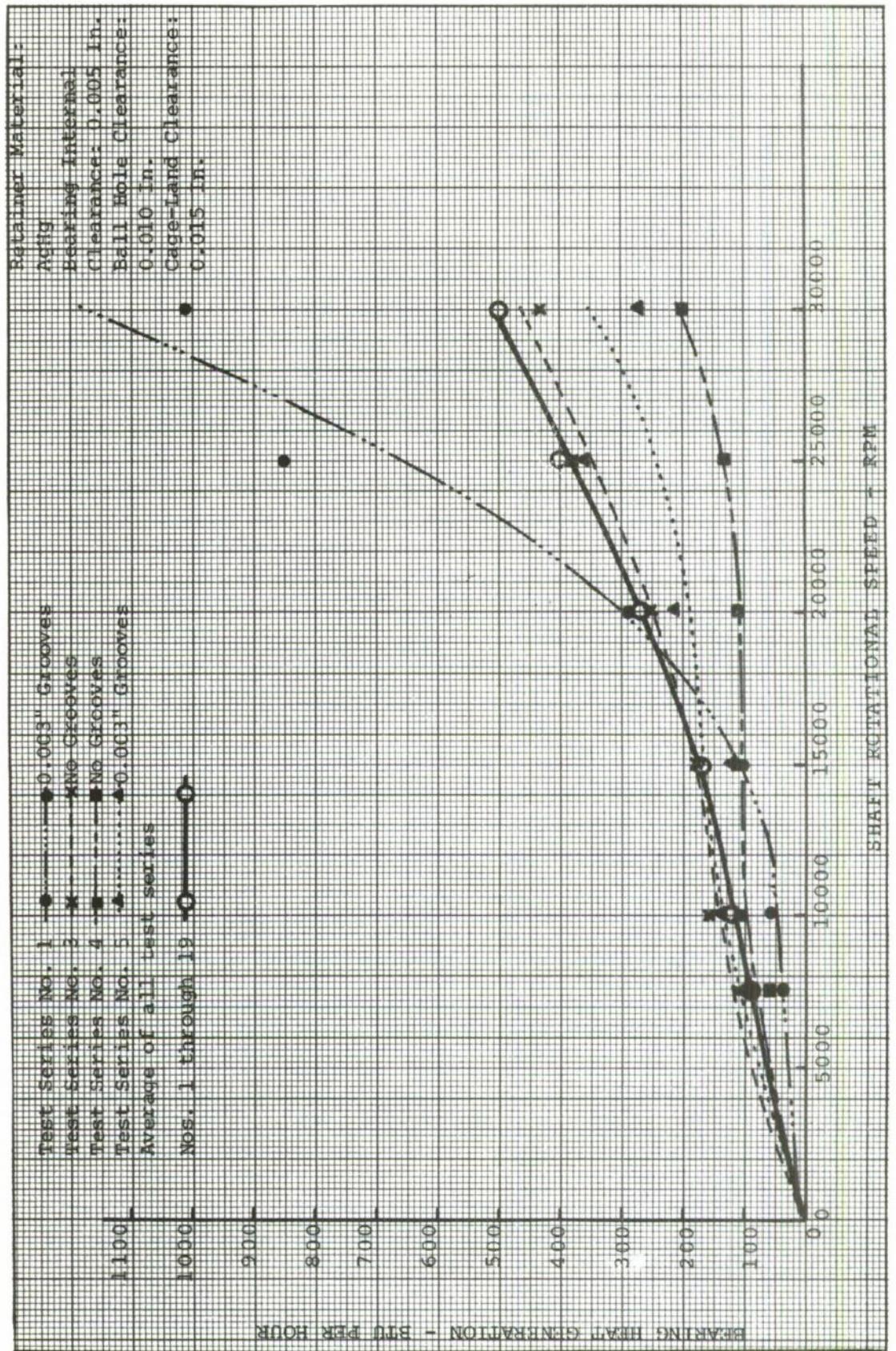


Figure 23. Bearing Heat Generation of Small Clearance AgHg Bearings at Various Speeds

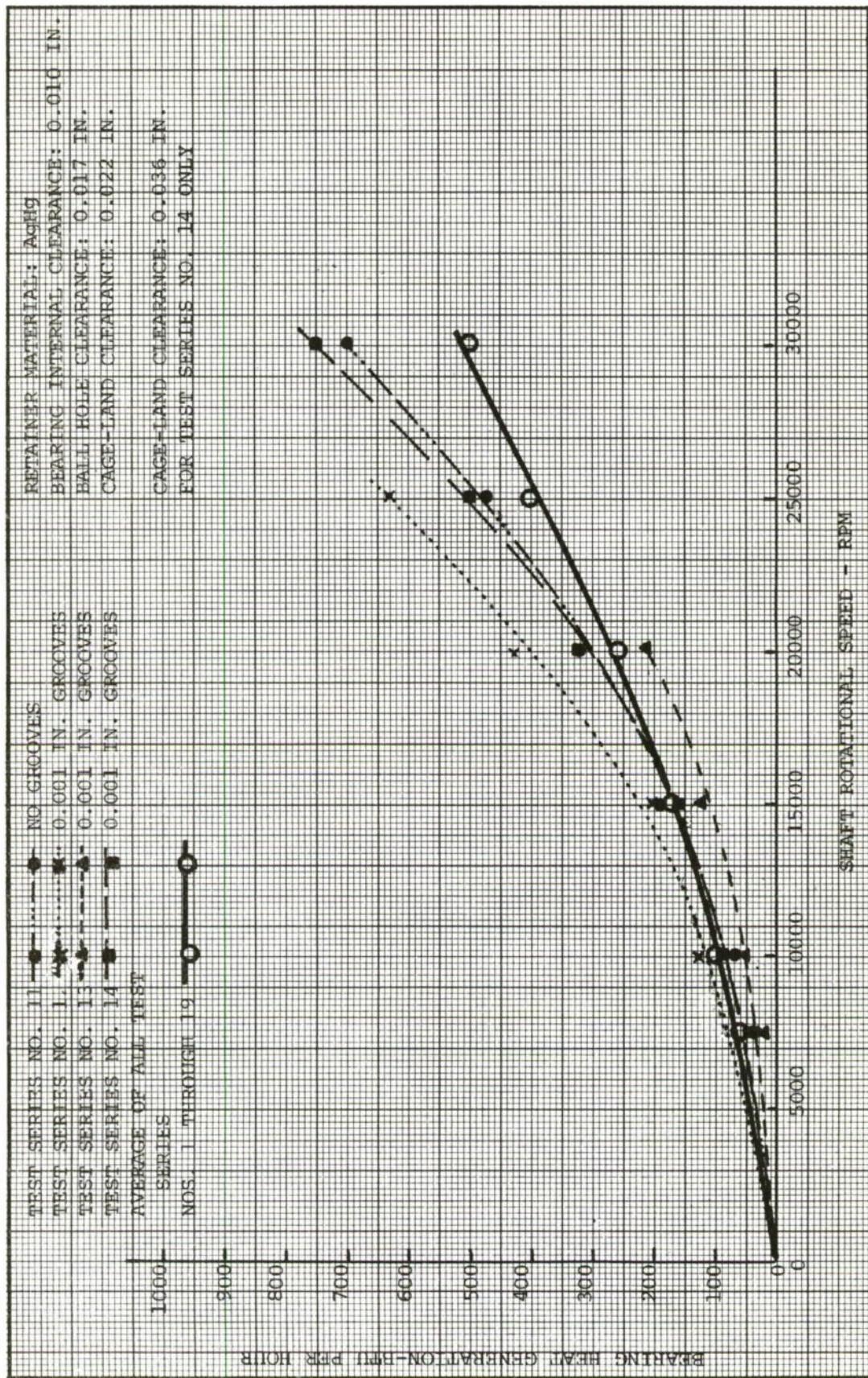


Figure 24. Bearing Heat Generation for Large Clearance AgHg Bearings at Various Speeds

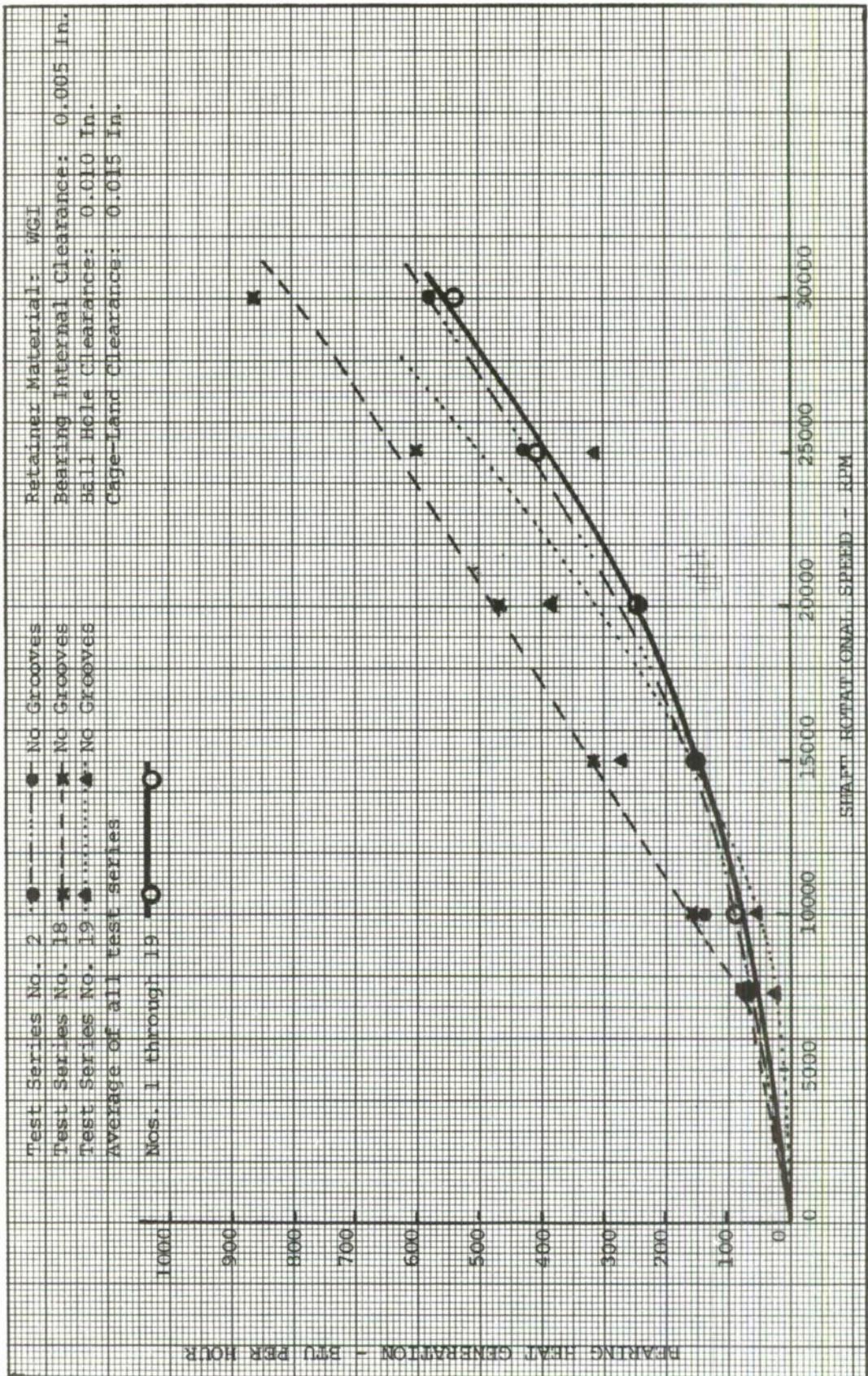


Figure 25. Bearing Heat Generation of Small Clearance WGI Bearings at Various Speeds

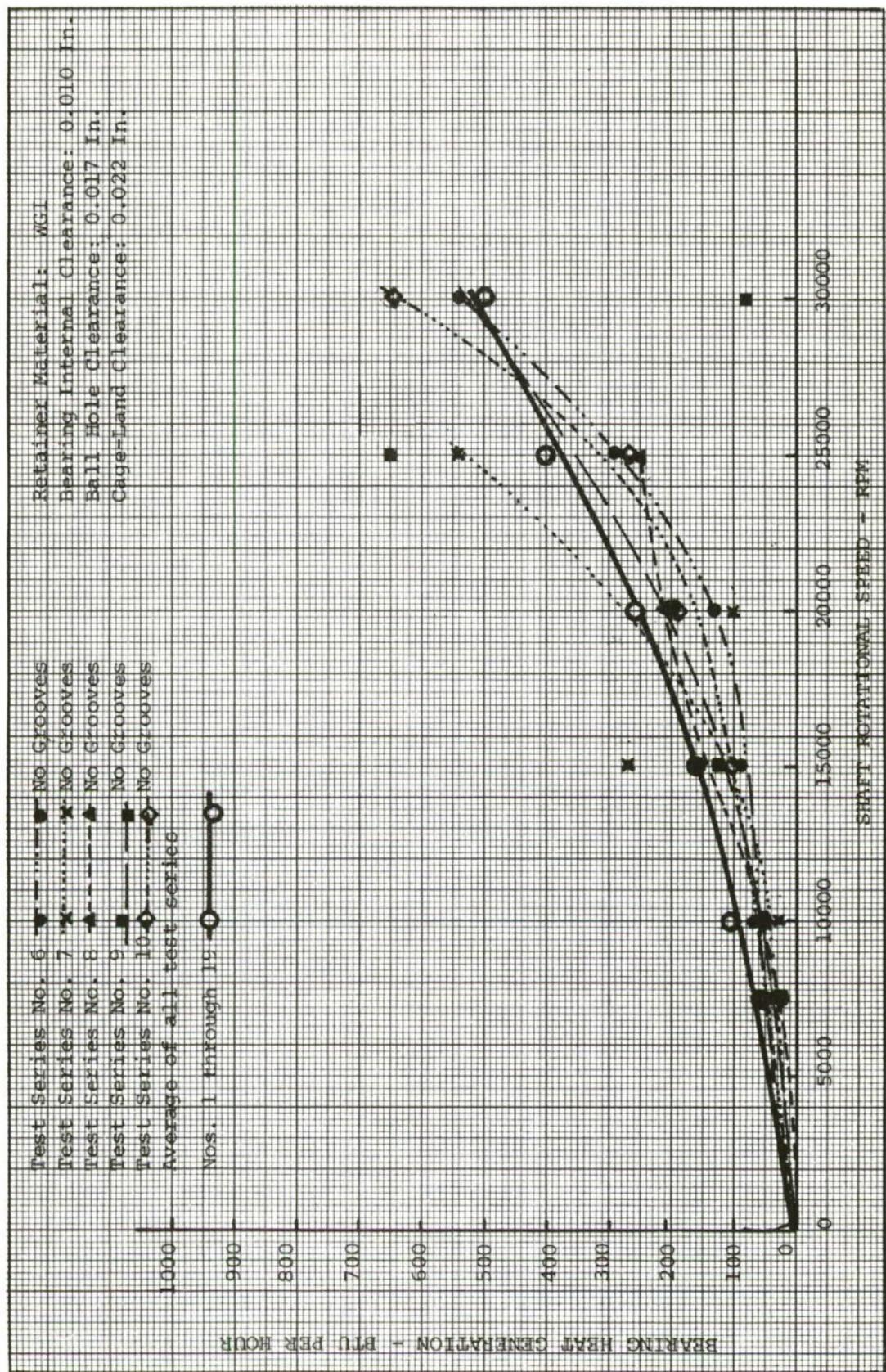


Figure 26. Bearing Heat Generation for Large Clearance WGI Bearings at Various Speeds

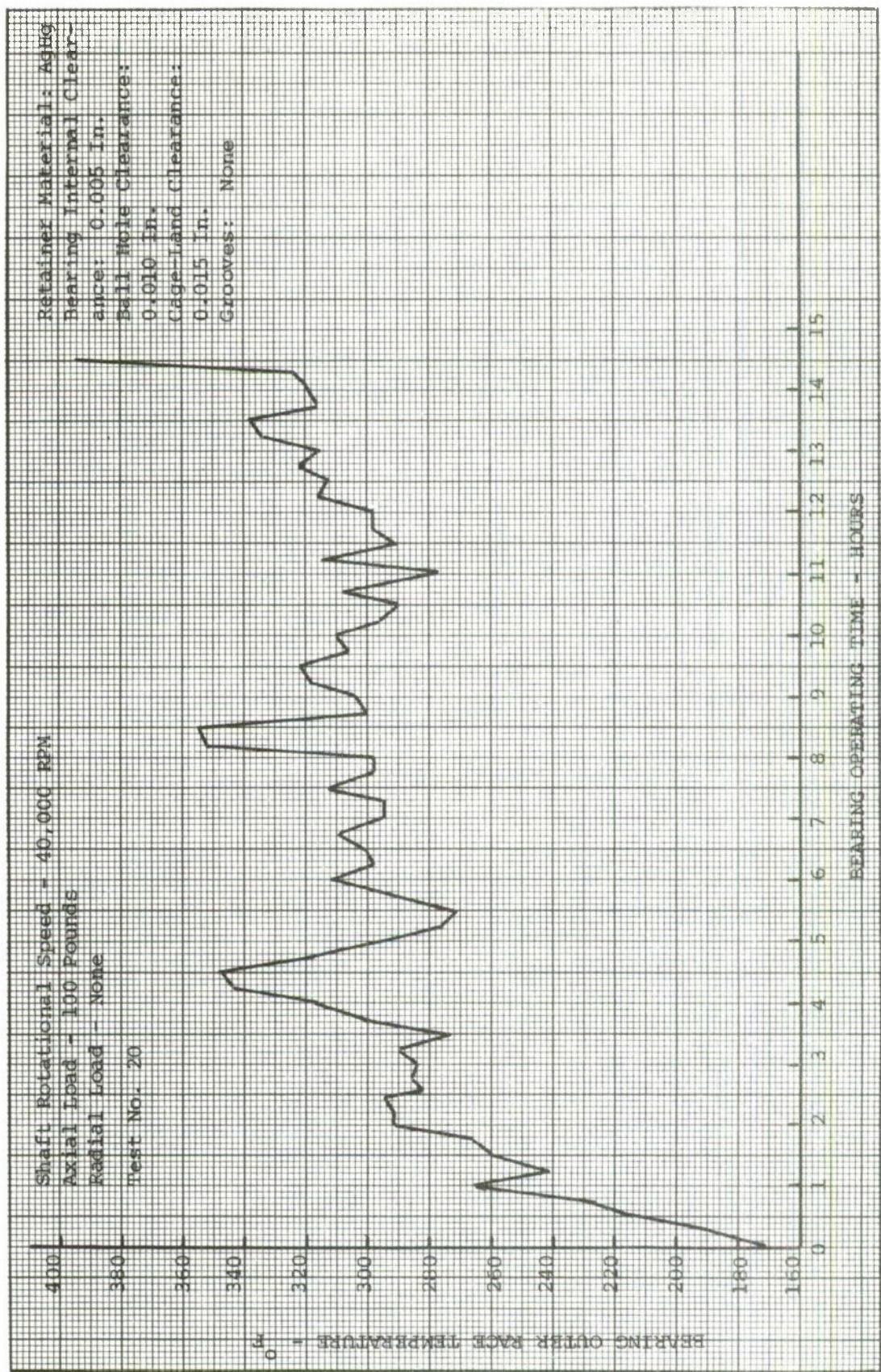


Figure 27. Variation of Bearing Outer Race Temperature with Time for AgHg Bearing Operating at 40,000 RPM

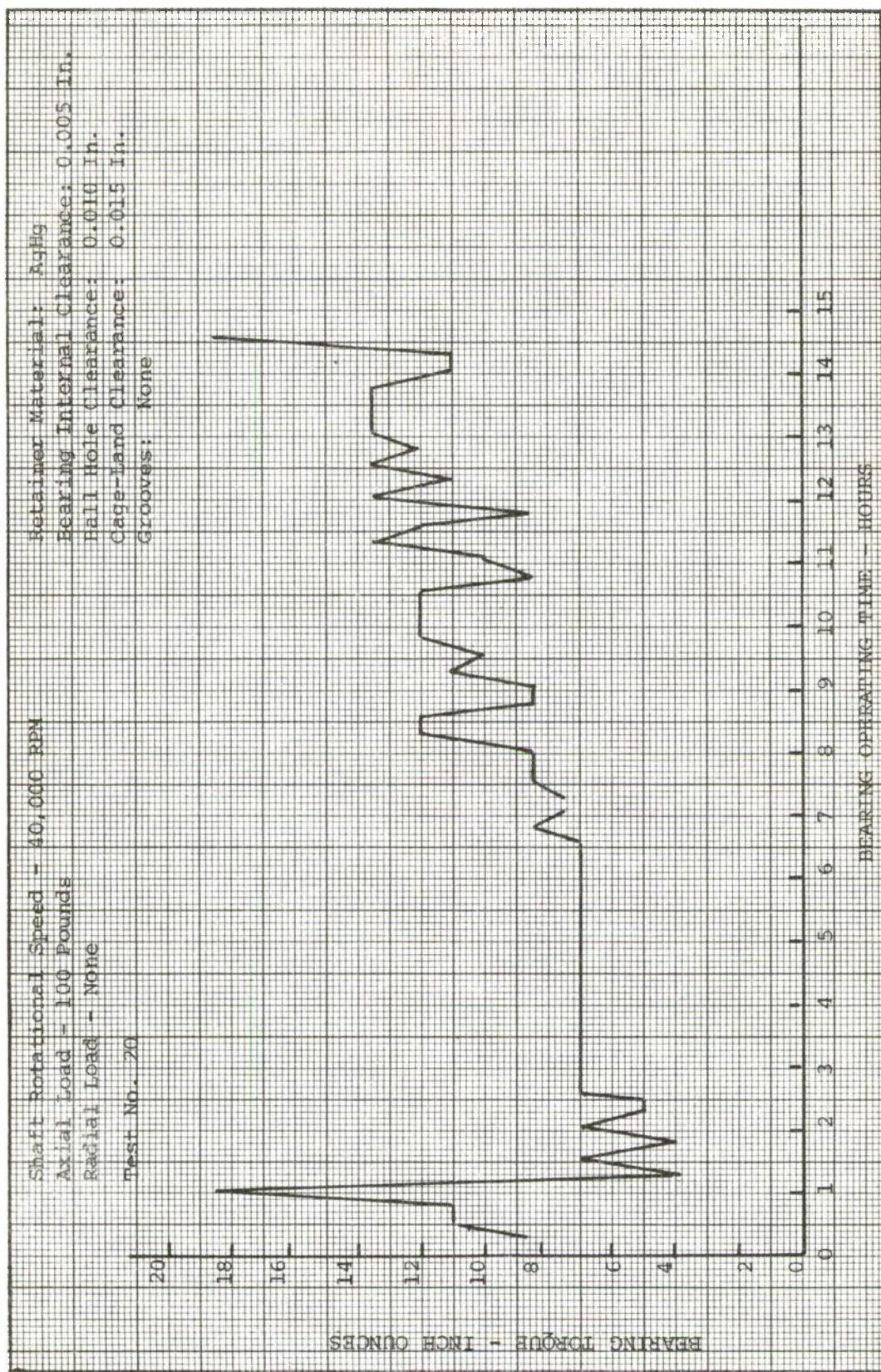


Figure 28. Variation of Bearing Torque with Time for AgHg Bearing  
Operating at 40,000 RPM

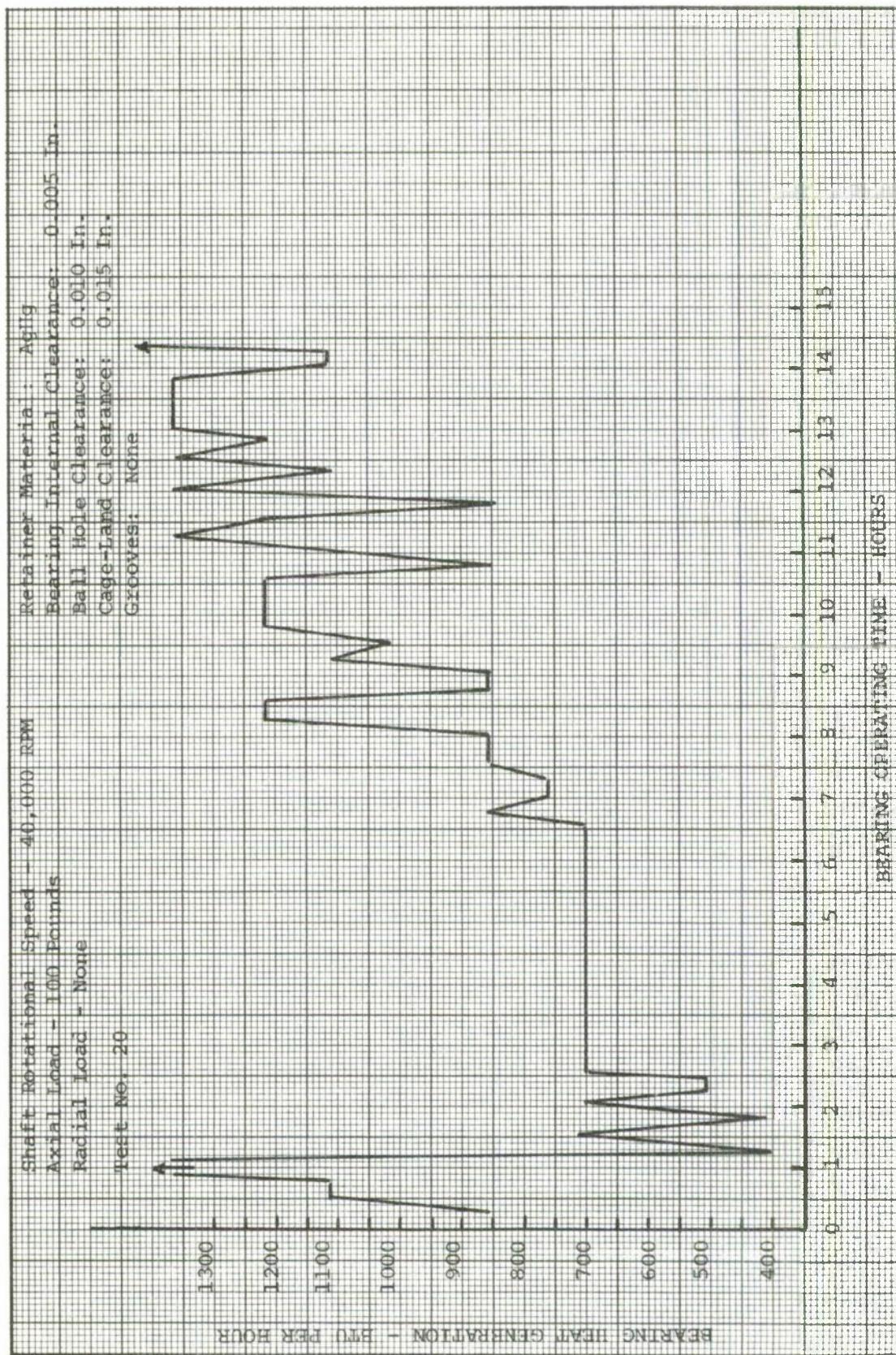


Figure 29. Variation of Bearing Heat Generation with Time for AgHg Bearing Operating at 40,000 RPM

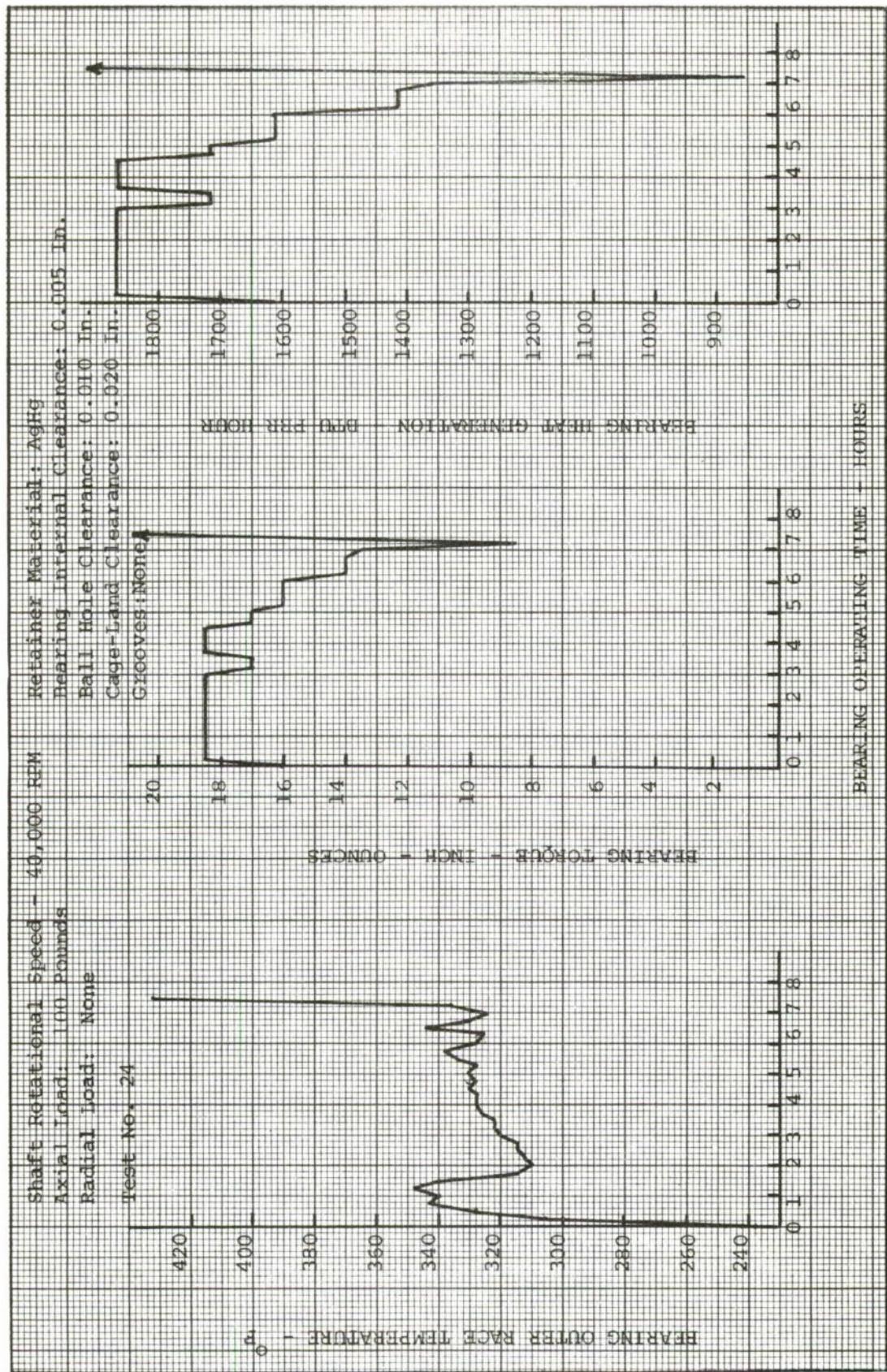


Figure 30. Variation of Bearing Outer Race Temperature, Torque and Heat Generation with Time of a AgHg Bearing Operating at 40,000 RPM

## CONCLUSIONS AND RECOMMENDATIONS

### CONCLUSIONS

1. The attempt to determine the effectiveness of grooves in the bearing inner race lands for pumping cooling air into the bearing was unsuccessful due to bearing cage imbalance problems at the higher speed conditions.
2. Bearings with AgHg composite retainers ran cooler and with less torque than those with WGI retainers.
3. Bearing radial and axial loads had little effect upon bearing operating temperatures and torque. This is in agreement with the results of other investigators.
4. Bearing operating speed had the most predominant effect on bearing operating temperature levels and torque. This is also in agreement with other investigators.
5. Inasmuch as heat generation is a function of both operating speed and torque, the effects of speed and load upon heat generation are comparable to conclusions 3 and 4 above. This has been verified most predominantly in Ref. 1-3, 5 & 6.
6. The 14 hr, 40,000 rpm test demonstrates a potential ultra high speed operating capability for solid lubricated ball bearings.
7. Cage imbalance due partly to machining inaccuracies and partly to the relatively heavy weight of the cage materials, has been shown to be a considerable problem at high speeds.

## RECOMMENDATIONS

1. Due to the imbalance problems encountered, it is recommended that future work be conducted to develop lighter weight solid lubricated retainers for use in ultra high speed applications.
2. Bearings employing AgHg or WGI cages should be dynamically balanced when their intended use involves operating speeds of 15,000 RPM or higher.

## LIST OF REFERENCES

1. Solid Lubricated Bearing Technology Part I - Solid Lubricated High Speed Ball Bearings, D. J. Boes, Westinghouse Research Laboratories, AFAPL-TR-71-69 Part I, September 1971.
2. Solid Lubricated Bearing Technology Part II - Solid Lubricated High Speed Ball Bearings, D. J. Boes, Westinghouse Research Laboratories, AFAPL-TR-71-69 Part II, December 1972.
3. Experimental Investigation of AgHg - WTE - MoSe<sub>2</sub> Solid Lubricated Ball Bearings for High Speed, High Temperature and High Load Applications, Ronald D. Dayton, Midwest Research Institute, AFAPL-TR-71-100, January 1972.
4. Rolling Bearing Analysis, Tedric A. Harris, John Wiley & Sons 1966, p454.
5. High Temperature, High Speed Solid Lubricated Bearing Technology Phase I - Heat Transfer, P. R. Bissett, R. L. Downey, R. A. Solomon, AiResearch Mfg Co of Ariz., AFAPL-TR-74-77, Volume I, August 1974.
6. High Temperature, High Speed Solid Lubricated Bearing Technology, Phase II - Test and Analysis, P. R. Bissett, R. L. Downey, R. A. Solomon, AiResearch Mfg Co of Ariz., AFAPL-TR-74-77, Volume II, July 1975.

## APPENDIX

TEST NO. 1 BRG. NO. 44 RETAINER AgNg INT. CL. 5 MILS BALL HOLE CL. 10 MILS GAGE LAND CL. 15 MILS GROOVES 3 MILS

DATE	TIME	AXIAL LOAD		RADIAL LOAD		BEARING TEMP.		BEARING TORQUE		SPEED	REMARKS	
		READING	RUNNING	PSI	LBS	PSI	LBS	I.R.	O.R.	READING	IN-OZ	
21-9-73	1245	-		35	50	0	0	-	-	-	2500	
	1300	15						81	0.1	2		
	1315	30						88	0.1	2		
	1330	45						88	0.1	2		
	1345	-						-	-	-	10000	
	1355	15						98	0.1	2		
	1400	30						98	0.1	2		
	1415	45						98	0.1	2		
	1430	-						-	-	-	15000	
	1445	15						118	0.15	3		
	1450	30						123	0.2	4		
	1500	45						125	0.15	3		
	1505	50						123	0.15	3		
	1515	-						123	0.15	3		
	1530	10						-	-	-	20000	
	1545	25						148	0.25	5		
	1555	40						168	0.25	5		
▼	1555	45						175	0.2	7		
	1555	-						177	0.35	7.5		
22-9-73	0745	-						-	-	-	1500	
	0800	15						95	0.1	2		
	0815	30						95	0.1	2		
	0815	-						-	-	-	10000	
	0830	15						100	0.1	2		
	0845	30						101	0.1	2		
	0900	45						102	0.1	2		
	0900	-						-	-	-	15000	
	0915	15						121	0.1	2		
	0930	30						128	0.1	2		
	0945	45						129	0.1	2		
	0945	-						-	-	-	20000	
	1000	15						157	0.2	4		
	1015	30						167	0.2	4		
	1030	45						172	0.2	4		
	1045	-						-	-	-	25000	
	1115	15						272	0.6	13.5		
	1130	30						298	0.6	13.5		
	1145	45						332	0.6	13.5		
	1145	-						350	0.6	13.5		
	1200	60						-	-	-	30000	
	1200	-						-	-	-	30000	
	1409	9						465	0.8	18.5		
	1415	15						570	0.6	13.5		
▼	1418	18						570	0.6	13.5		
								-	-	-		

Evidence of cage unbalance, uneven wear and ball-chiod contact. Oil contamination present

TEST NO. 2 [BRG NO 48] RETAINER W/GI INT CL 5 MILS [BALL HOLE CL 10 MILS] GAGE LAND CL 15 MILS GROOVES NO.

TIME DATE	AXIAL LOAD READINGS	RADIAL LOAD PSI	BEARING TEMP. LBS	BEARING TORQUE PSI	SPEED IN-OZ	REMARKS	RPM
	RUNNING	LBS	PSI	LBS	IN-OZ		RPM
23-7-24	1500	-	43	75	0	0	7500
	1515	15			76	88	+0.1
	1545	-			87	96	-0.5
	1500	15			84	94	-0.5
	1500	-			105	109	+0.5
	1515	15			104	102	+0.5
	1530	30			103	98	+0.5
	1545	45			103	98	+0.5
	1600	-			-	-	-
	1615	15			-	-	20000
	1630	30			127	118	-0.2
	1645	45			129	124	-0.2
	1700	-			167	122	-0.2
	1715	15			163	152	-0.2
	1730	30			157	140	-0.2
	1745	45			157	140	-0.2
	1800	-			191	174	-0.3
	1815	15			191	124	-0.3
	1830	30			-	-	-
	1845	45			-	-	-
	1900	-			-	-	-
	1915	15			-	-	-
	1930	30			-	-	-
	1945	45			-	-	-
	2000	-			-	-	-
	2015	20			93	91	+0.1
	2030	30			93	91	+0.1
	2045	45			-	-	-
	2100	-			103	104	+0.1
	2115	10			104	104	+0.1
	2130	20			-	-	-
	2145	30			131	120	+0.25
	2200	-			131	120	+0.25
	2215	15			131	120	+0.25
	2230	30			131	120	+0.25
	2245	45			131	120	+0.25
	2300	-			146	132	-0.2
	2315	15			145	130	-0.2
	2330	30			-	-	-
	2345	45			-	-	-
	2400	-			170	148	-0.3
	2415	15			177	156	-0.3
	2430	30			178	160	-0.3
	2445	45			191	168	-0.2
	2500	-			193	172	-0.3
	2515	15			192	170	-0.3
	2530	30			192	170	-0.3
	2545	45			192	170	-0.3
	2600	-			-	-	-
	2615	15			87	96	-0.2
	2630	30			85	94	-0.2
	2645	45			-	-	-
	2700	-			91	98	-0.2
	2715	15			91	98	-0.2
	2730	30			91	98	-0.2
	2745	45			-	-	-
	2800	-			110	110	-0.15
	2815	15			110	110	-0.15
	2830	30			110	110	-0.15
	2845	45			-	-	-
	2900	-			124	118	-0.1
	2915	15			126	120	-0.1
	2930	30			126	120	-0.1
	2945	45			137	124	-0.2
	3000	-			137	124	-0.2
	3015	15			137	124	-0.2
	3030	30			137	124	-0.2
	3045	45			-	-	-
	3100	-			192	160	-0.3
	3115	15			192	160	-0.3
	3130	30			192	168	-0.3
	3145	45			192	168	-0.3
	3200	-			-	-	-
	3215	15			88	94	-0.3
	3230	30			88	94	-0.3
	3245	45			-	-	-
	3300	-			97	100	-0.3
	3315	5			98	102	-0.2
	3330	15			96	100	-0.3
	3345	20			-	-	-
	3400	-			117	113	0.2
	3415	10			118	116	0.2
	3430	20			118	118	0.2
	3445	30			118	118	0.2
	3500	-			-	-	-
	3515	45			-	-	-
	3530	5			-	-	-
	3545	15			-	-	-
	3600	-			-	-	-
	3615	10			-	-	-
	3630	20			-	-	-
	3645	30			-	-	-
	3700	-			-	-	-
	3715	45			-	-	-
	3730	5			-	-	-
	3745	15			-	-	-
	3800	-			-	-	-
	3815	10			-	-	-
	3830	20			-	-	-
	3845	30			-	-	-
	3900	-			-	-	-
	3915	45			-	-	-
	3930	5			-	-	-
	3945	15			-	-	-
	4000	-			-	-	-
	4015	10			-	-	-
	4030	20			-	-	-
	4045	30			-	-	-
	4100	-			-	-	-
	4115	45			-	-	-
	4130	5			-	-	-
	4145	15			-	-	-
	4200	-			-	-	-
	4215	10			-	-	-
	4230	20			-	-	-
	4245	30			-	-	-
	4300	-			-	-	-
	4315	45			-	-	-
	4330	5			-	-	-
	4345	15			-	-	-
	4400	-			-	-	-
	4415	10			-	-	-
	4430	20			-	-	-
	4445	30			-	-	-
	4500	-			-	-	-
	4515	45			-	-	-
	4530	5			-	-	-
	4545	15			-	-	-
	4600	-			-	-	-
	4615	10			-	-	-
	4630	20			-	-	-
	4645	30			-	-	-
	4700	-			-	-	-
	4715	45			-	-	-
	4730	5			-	-	-
	4745	15			-	-	-
	4800	-			-	-	-
	4815	10			-	-	-
	4830	20			-	-	-
	4845	30			-	-	-
	4900	-			-	-	-
	4915	45			-	-	-
	4930	5			-	-	-
	4945	15			-	-	-
	5000	-			-	-	-
	5015	10			-	-	-
	5030	20			-	-	-
	5045	30			-	-	-
	5100	-			-	-	-
	5115	45			-	-	-
	5130	5			-	-	-
	5145	15			-	-	-
	5200	-			-	-	-
	5215	10			-	-	-
	5230	20			-	-	-
	5245	30			-	-	-
	5300	-			-	-	-
	5315	45			-	-	-
	5330	5			-	-	-
	5345	15			-	-	-
	5400	-			-	-	-
	5415	10			-	-	-
	5430	20			-	-	-
	5445	30			-	-	-
	5500	-			-	-	-
	5515	45			-	-	-
	5530	5			-	-	-
	5545	15			-	-	-
	5600	-			-	-	-
	5615	10			-	-	-
	5630	20			-	-	-
	5645	30			-	-	-
	5700	-			-	-	-
	5715	45			-	-	-
	5730	5			-	-	-
	5745	15			-	-	-
	5800	-			-	-	-
	5815	10			-	-	-
	5830	20			-	-	-
	5845	30			-	-	-
	5900	-			-	-	-
	5915	45			-	-	-
	5930	5			-	-	-
	5945	15			-	-	-
	6000	-			-	-	-
	6015	10			-	-	-
	6030	20			-	-	-
	6045	30			-	-	-
	6100	-			-	-	-
	6115	45			-	-	-
	6130	5			-	-	-
	6145	15			-	-	-
	6200	-			-	-	-
	6215	10			-	-	-
	6230	20			-	-	-
	6245	30			-	-	-
	6300	-			-	-	-
	6315	45			-	-	-
	6330	5			-	-	-
	6345	15			-	-	-
	6400	-			-	-	-
	6415	10			-	-	-
	6430	20			-	-	-
	6445	30			-	-	-
	6500	-			-	-	-
	6515	45			-	-	-
	6530	5			-	-	-
	6545	15			-	-	-
	6600	-			-	-	-
	6615	10			-	-	-
	6630	20			-	-	-
	6645	30			-	-	-
	6700	-			-	-	-
	6715	45			-	-	-
	6730	5			-	-	-
	6745	15			-	-	-
	6800	-			-	-	-
	6815	10			-	-	-
	6830	20			-	-	-
	6845	30			-	-	-
	6900	-			-	-	-
	6915	45			-	-	-
	6930	5			-	-	-
	6945	15			-	-	-
	7000	-			-	-	-
	7015	10			-	-	-
	7030	20			-	-</td	

TEST NO. 2   BRG. NO 48   RETAINER W/G   INT. CL. 5 MILS   BALL HOLE CL. 10 MILS   GAGE LUND CL. 15 MILS   GRIDES. NO.												
DATE	TIME	AXIAL LOAD		RADIAL LOAD		BEARING TEMP.		BEARING TORQUE		SPEED	REMARKS	
		READING	RUNNING	PSI	LBS	PSI	LBS	I.R.	O.R.	READING IN-OZ	RPM	
24-7-74	1430	10	67	150	0	0	0	130	124	-0.3	7	20000
	1440	20						128	123	-0.3	7	
	1450	30						129	123	-0.3	7	
	1450	-						-	-	-	25000	
	1500	10						138	125	-0.2	4	
	1510	20						143	126	-0.2	4	
	1520	30						143	128	-0.2	4	▼
	1520	-						179	160	-0.2	7	30000
	1540	20						184	170	-0.2	4	
	1550	30	▼	▼	▼	▼	▼	184	170	-0.2	4	▼
25-7-74	0945	-	67	150	8	25	-	-	-	-	2500	
	1000	15						87	94	-0.2	4	
	1010	25						85	94	-0.2	4	▼
	1020	-						-	-	-	10000	
	1030	10						90	97	-0.2	4	
	1030	20						90	98	-0.2	4	▼
	1040	-						-	-	-	15000	
	1050	10						101	102	-0.1	2	
	1050	20						102	102	0	0	▼
	1050	-						-	-	-	20000	
	1100	10						127	118	-0.2	4	
	1105	15						128	122	-0.2	4	
	1115	25						128	122	-0.2	4	▼
2-8-74	1250	-						-	-	-	25000	
	1305	15						205	164	-0.7	16	
	1315	25						225	184	-0.7	16	
	1325	35						225	190	-0.7	16	
	1330	40						225	190	-0.7	16	▼
	1330	-						-	-	-	30000	
	1335	5						261	210	-0.6	13.5	
	1345	15						268	210	-0.7	16	
	1350	20						275	220	-0.7	16	
	1355	25						287	228	-0.6	13.5	
	1400	30	▼	▼	▼	▼	▼	285	229	-	7	▼
6-8-74	0910	-	67	150	16	50	198	151	-0.25	5	7500	
	0920	10					128	138	-0.25	5		
	0930	20					126	131	-0.25	5		
	0940	30					121	126	-0.25	5		
	0950	40					121	126	-0.25	5	▼	
	0950	-					-	-	-0.4	8.5	10000	
	0950	10					163	168	-0.4	8.5		
	0950	20					163	165	-0.45	10	▼	
	0950	-					-	-	-	-	15000	
	0950	10					159	140	-0.1	2		
	0950	20					220	180	-0.15	3		
	0950	30					215	200	-0.15	3	▼	
5-8-74	1510	-					-	-	-	-	20000	
	1515	5					214	194	-0.9	20.5		
	1525	15					214	190	-0.9	20.5		
	1530	20					214	189	-0.9	20.5	▼	
	1540	-					-	-	-	-	25000	
	1545	5					216	206	-0.6	13.5		
	1550	20					248	208	-0.6	13.5		
	1550	30					298	206	-	-	▼	
	1550	-					232	202	-0.8	8.5	30000	
	1550	10					240	190	-0.5	11		
	1550	20					225	192	-0.5	11		
	1550	30					274	208	-0.55	12.5		
	1550	40	▼	▼	▼	▼	274	196	-0.4	8.5	▼	
6-8-74	0950	-	67	150	24	75	-	-	-	-	7500	
	1000	10					94	112	-0.1	2		
	1005	15					84	104	-0.1	2		
	1010	20					85	104	-0.1	2		
	1020	-					53	102	-0.05	1	10000	
	1020	10					93	100	-0.05	1	▼	
	1020	-					118	112	0	0	15000	
	1030	10					124	120	0	0		
	1040	20					126	122	+0.05	1		
	1050	30					126	122	+0.05	1	▼	
	1050	-					150	130	-0.35	7.5	20000	

TEST NO. 2 BRG. NO 48 RETAINER W/GI INT. CL. 5 MILS BALL HOLE CL. 18. MILS GAGE LAND CL. 15 MILS GATEYES NO

TEST NO. 3 BRG. NO 49 RETAINER AgMg INT. CL. 5 MILS DALL HOLE CL. 10 MILS CAGE LAND CL. 15 MILS GROOVES NO.

TIME DATE	READING RUNNING	AXIAL LOAD PSI	RADIAL LOAD LBS	BEARING TEMP. I.R. O.R.	BEARING TORQUE READING IN-OZ	SPEED RPM	REMARKS
8-8-74	1245	-	43	75	0	0	-
	1300	15			93	92	-0.1 2
	1310	25			88	8.9	-0.1 2
	1310	-			-	-	-
	1320	10			93	90	-0.05 1
	1330	20			93	90	-0.05 1
	1330	-			-	-	-
	1340	10			101	96	-0.05 1
	1400	30			102	98	-0.05 1
	1410	40			102	98	-0.05 1
	1410	-			-	-	-
	1420	10			123	112	+0.05 1
	1430	20			123	112	+0.05 1
	1430	-			-	-	-
	1440	10			140	124	0 0
	1450	20			142	126	0 0
	1500	30			143	128	0 0
	1500	-			175	150	-0.1 2
	1515	15			182	158	-0.1 2
	1530	90	▼	▼	192	158	-0.1 2
9-8-74	0810	-	51	109	0	0	-
	0830	10			92	99	-0.3 7
	0830	20			93	98	-0.3 7
	0840	30			88	94	-0.3 7
	0840	-			-	-	-
	0855	15			91	91	-3 7
	0910	30			89	91	-0.35 7.5
	0920	40			89	91	-0.35 7.5
	0920	-			-	-	-
	0930	10			107	102	-0.4 8.5
	0940	20			104	102	-0.4 8.5
	0950	30			104	102	-0.4 8.5
	0950	-			-	-	-
	1000	10			114	104	-0.4 8.5
	1010	20			114	104	-0.4 8.5
	1010	-			-	-	-
	1020	10			132	114	-0.45 10
	1030	20			173	116	-0.45 10
	1030	-			-	-	-
	1045	15			173	149	-0.5 11
	1100	30	▼	▼	173	150	-0.5 11
9-8-74	1300	-	59	125	0	0	-
	1310	10			93	94	-0.3 7
	1310	-			94	94	-0.3 7
	1320	10			-	-	-
	1330	20			94	98	-4.3 7
	1330	-			94	97	-0.3 7
	1340	10			-	-	-
	1350	20			112	108	-0.2 4
	1350	-			112	108	-0.2 4
	1400	10			-	-	-
	1410	20			118	108	-0.3 7
	1410	-			118	108	-0.3 7
	1420	10			-	-	-
	1430	20			138	117	-0.35 7.5
	1440	30			142	121	-0.35 7.5
	1440	-			142	121	-0.35 7.5
	1450	10			-	-	-
	1510	30			182	154	-0.45 10
	1520	40	▼	▼	183	156	-0.45 10
9-8-74	0800	-	67	150	0	0	-
	0810	10			98	98	-0.4 8.5
	0820	20			93	95	-0.4 8.5
	0820	-			94	94	-0.4 8.5
	0830	10			-	-	-
	0840	20			95	96	-0.35 7.5
	0850	30			93	94	-0.35 7.5
	0850	-			94	96	-0.35 7.5
	0900	10			-	-	-
	0910	20	▼	▼	104	100	-0.35 7.5
	0910	-			103	100	-0.35 7.5

TEST NO. 3 | BRG NO 49 RETAINER A9Hq INT CL 5 MILS BALL HOLE CL 10 MILS CAGE LND CL 15 MILS GROOVES NO

TIME		AXIAL LOAD	RADIAL LOAD	BEARING TEMP	BEARING TORQUE	SPEED	REMARKS					
DATE	READING	RUNNING	PSI	LBS	PSI	LBS	I.R.	O.R.	READING	IN-OZ	RPM	
14-8-74	0910	-	78	67	150	0	0	-	-	-	20000	
	0920	10					118	106	-0.4	8.5		
	0930	20					119	108	-0.4	8.5		
	0940	30					120	108	-0.4	8.5	▼	
	0940	-					-	-	-	-	25000	
	0950	10					144	122	-0.4	8.5		
	1005	25					146	125	-0.4	8.5		
	1015	35					147	126	-0.4	8.5		
	1030	50					147	126			▼	
	1030	-					-	-	-	-	30000	
	1040	10					175	142	-0.5	11		
	1050	20					180	149	-0.5	11		
▼	1100	30	▼	▼	▼	▼	180	149	-0.5	11	▼	
12-8-74	1300	-	67	150	8	25	91	96	-0.1	2	7500	
	1310	10					88	90	-0.1	2	▼	
	1310	-					-	-	-	-	10000	
	1320	10					93	98	-0.1	2		
	1330	20					92	98	-0.1	2	▼	
	1330	-					-	-	-	-	15000	
	1340	10					99	102	-0.05	1		
	1350	20					99	102	-0.05	1	▼	
	1350	-					-	-	-	-	20000	
	1400	10					119	111	-0.05	1		
	1410	20					120	113	-0.05	1		
	1420	30					120	114	-0.05	1	▼	
	1420	-					-	-	-	-	25000	
	1430	10					138	122	-0.15	3		
	1440	20					140	126	-0.15	3		
	1450	30					140	126	-0.15	3	▼	
	1450	-					-	-	-	-	30000	
	1500	10					166	162	-0.2	4		
	1510	20					172	147	-0.2	4		
	1520	30					174	151	-0.2	4		
▼	1530	40	▼	▼	▼	▼	174	151	-0.2	4	▼	-
13-8-74	0830	-	67	150	16	50	93	101	-0.1	2	7500	
	0840	10					93	101	-0.1	2	▼	
	0840	-					-	-	-	-	10000	
	0850	10					94	102	-0.1	2		
	0860	20					94	102	-0.1	2	▼	
	0900	-					-	-	-	-	15000	
	0910	10					101	104	-0.1	2		
	0920	20					102	104	-0.1	2	▼	
	09	-					-	-	-	-	20000	
	0930	10					121	114	-0.15	3		
	0940	20					121	114	-0.15	3		
	0950	30					121	115	-0.15	3	▼	
	0950	-					-	-	-	-	25000	
	1000	10					136	124	-0.15	3		
	1015	25					140	128	-0.15	3		
	1030	40					140	129	-0.15	3	▼	
	1030	-					-	-	-	-	30000	
	1045	15					162	148	-0.2	4		
	1100	30					164	148	-0.2	4		
▼	1115	45	▼	▼	▼	▼	164	148	-0.2	4	▼	
13-8-74	1300	-	67	150	24	75	92	100	-0.25	5	7500	
	1310	10					90	98	-0.25	5		
	1320	20					90	98	-0.25	5	▼	
	1320	-					-	-	-	-	10000	
	1330	10					94	100	-0.3	7		
	1340	20					94	100	-0.3	7	▼	
	1340	-					-	-	-	-	15000	
	1350	10					115	114	-0.3	7		
	1400	20					116	116	-0.3	7		
	1410	30					116	117	-0.3	7	▼	
	1410	-					-	-	-	-	20000	
	1420	10					122	116	-0.35	7.5		
	1430	20					124	118	-0.35	7.5		
	1440	30					124	118	-0.35	7.5	▼	
	1440	-					-	-	-	-	25000	
▼	1450	10					134	126	-0.35	7.5	▼	

TEST NO. 3 BRG. NO 49 RETAINER A.H. INT. CL 5 MILS BALL HOLE CL 10 MILS CAGE LAND CL 15 MILS GROOVES NO

TIME	AXIAL LOAD	RADIAL LOAD	BEARING TEMP	BEARING TORQUE	SPEED	REMARKS					
DATE	READING	PSI	LBS	PSI	LBS	I.R.	O.R.	READING	IN-OZ	RPM	
13-8-74	1500	20	67	150	24	75	140	128	-0.35	7.5	25000
	1510	30					140	128			↓
	1520	—					—	—	—	—	30000
	1520	10					167	147	-0.4	8.5	
	1530	20					168	152	-0.4	8.5	
	1540	30					168	152	-0.4	8.5	↓
14-8-74	0800	—	43	75	0	0	90	98	-0.1	2	7500
	0810	10					88	95	-0.1	2	
	0820	20					84	90	-0.1	2	
	0830	30					84	90	-0.1	2	↓
	0830	—					—	—	—	—	10000
	0840	10					90	96	-0.15	3	
	0850	20					90	96	-0.15	3	↑
	0850	—					—	—	—	—	15000
	0900	10					104	104	-0.2	4	
	0910	20					104	104	-0.2	4	↑
	0910	—					—	—	—	—	20000
	0920	10					129	115	-0.05	1	
	0930	20					127	119	0	0	
	0940	30					128	122	-0.05	1	
	0950	40					128	122	-0.05	1	↑
	0950	—					—	—	—	—	25000
	1000	10					141	128	-0.2	4	
	1010	20					141	129	-0.2	4	
	1020	30					141	129	-0.2	4	↓
	1020	—					—	—	—	—	30000
	1120	—					166	130	+0.3	7	
	1130	10					173	144	+0.25	5	
	1140	20					175	145	+0.25	5	
	1150	30					175	145	+0.25	5	↓
12-8-74	1300	—	43	75	8	25	89	95	+0.25	5	7500
	1310	10					84	94	+0.3	7	
	1320	20					84	93	+0.3	7	↓
	1320	—					—	—	—	—	10000
	1340	20					84	92	+0.4	8.5	
	1400	40					84	92	+0.4	8.5	↑
	1400	—					—	—	—	—	15000
	1410	10					94	98	+0.2	4	
	1420	20					94	98	+0.2	4	↑
	1420	—					—	—	—	—	20000
	1430	10					109	106	+0.1	2	
	1440	20					113	108	+0.3	7	
	1500	40					113	108	+0.3	7	↑
	1500	—					133	120	+0.2	4	25000
	1510	10					133	122	+0.2	4	
	1520	20					133	122	+0.2	4	↓
	1520	—					159	138	-0.6	13.5	30000
	1530	10					166	146	-0.6	13.5	
	1540	20					166	146	-0.6	13.5	↑
	1545	—	43	75	16	50	88	94	+0.5	11	7500
	1455	10					84	94	+0.6	13.5	
	1505	20					82	92	+0.6	13.5	
	1515	30					82	92	+0.6	13.5	↑
	1515	—					83	92	+0.6	13.5	10000
	1525	10					83	92	+0.6	13.5	↓
	1525	—					—	—	—	—	15000
	1535	10					94	96	+0.5	11	
	1545	20					95	98	+0.5	11	
	1550	25					95	98	+0.5	11	↓
23-8-74	0745	—					122	114	+0.3	7	20000
	0755	10					118	114	+0.3	7	
	0805	20					118	114	+0.3	7	↓
	0805	—					—	—	—	—	25000
	0815	10					137	122	+0.3	7	
	0825	20					140	128	+0.3	7	
	0825	30					140	128	+0.3	7	↑
	0835	—					—	—	—	—	30000
	0845	10					165	148	+0.2	4	
	0855	20					167	148	+0.2	4	
	0855	30					168	150	+0.2	4	↓
	0905	—	43	75	16	50	168	150	+0.2	4	↓

TEST NO. 3 BRG NO 49 RETAINER RHT INT. CL 5 MILS BALL HOLE CL 10 MILS GAGE LAND CL 15 MILS GROOVES NO.

TIME	AXIAL LOAD	RADIAL LOAD	BEARING TEMP.	BEARING TORQUE	SPEED	REMARKS					
DATE	READING	RUNNING	PSI	LBS	PSI	LBS	I.R.	O.R.	READING	IN-OZ	RPM
23-8-74	0915	40	43	75	16	50	170	151	+0.2	4	36000
	0925	50							+0.5	3	↓
23-8-74	1145	-	43	75	24	75	88	102	+0.5	11	7500
	1155	10							0.5	"	
	1200	20							0.5	"	↓
	1220	-							-	-	10000
	1225	5							0.6	13.5	
	1235	15							0.6	13.5	
	1245	25							0.6	13.5	↓
	1250	-							-	-	15000
	1300	10							0.3	7	
	1310	20							0.3	7	
	1320	30							0.3	7	↓
	1330	-							-	-	20000
	1340	10							0.2	4	
	1350	20							0.2	4	↓
	0955	-							-	-	25000
	1000	5							0.3	7	
	1010	15							0.3	7	
	1020	25							0.3	7	
	1030	35							0.3	7	↓
	0925	-							-	-	36000
	0935	10							0.15	3	
	0945	20							0.15	3	
	0955	30							0.15	3	↓
23-9-74	0800	-	51	100	8	25	88	92	+0.1	2	7500
	0810	10							0.2	4	
	0820	20							0.2	4	↓
	0825	-							-	-	10000
	0830	10							0.1	2	
	0840	20							0.1	2	↓
	0840	-							-	-	15000
	0850	10							0.2	4	
	0900	20							0.2	4	↓
	0910	30							0.2	4	↓
	0920	-							-	-	20000
	0920	10							0.5	11	
	0930	20							0.5	11	
	0940	30							0.5	11	↓
	0940	-							-	-	25000
	0950	10							0.7	16	
	1000	20							0.7	16	
	1010	30							0.7	16	↓
	1020	-							-	-	30000
	1020	10							0.05	1	
	1030	20							0.05	1	
	1040	30							0.05	1	
	1050	40							0.05	1	↓
12-9-74	1250	-	51	100	16	50	86	92	+0.1	2	7500
	1300	10							0.1	2	
	1310	20							0.1	2	↓
	1310	-							-	-	10000
	1320	10							0.2	4	
	1330	20							0.2	4	
	1340	30							0.2	4	↓
	1340	-							-	-	15000
	1350	10							0.1	2	
	1400	20							0.1	2	↓
	1400	-							-	-	20000
	1410	10							0	0	
	1420	20							0	0	
	1430	30							0	0	↓
	1430	-							-	-	25000
	1440	10							0.1	2	
	1450	20							0.1	2	
	1500	30							0.1	2	↓
	1500	-							-	-	30000
	1510	10							0.05	1	
	1520	20							0.05	1	
	1530	30							0.05	1	↓

TEST NO. 3 | BRG. NO. 49 | RETAINER A9H9 | INT. CL. 5 MILS | BALL HOLE CL. 10. MILS | GAGE LAND CL. 15. MILS | GROOVES NO.

DATE	TIME READING	AXIAL LOAD		RADIAL LOAD		BEARING TEMP.		BEARING TORQUE		SPEED RPM	REMARKS
		PSI	LBS	PSI	LBS	I.R.	O.R.	READING	IN-OZ		
13-974	0748	-	54	100	24	75	92	96	+0.2	4	7500
	0755	10					89	96	+0.2	4	
	0805	20					88	96			↓
	0805	-					-	-	-	-	10000
	0810	5					93	98	+0.3	7	
	0820	15					92	98	+0.3	7	↓
	0820	-					-	-	-	-	15000
	0830	10					101	102	+0.1	2	
	0840	20					101	103	+0.1	2	↓
	0840	-					-	-	-	-	20000
	0850	10					110	108	-0.1	2	
	0900	20					110	110	-0.1	2	
	0910	30					115	112	-0.1	2	
	0920	40					115	112	-0.1	2	↓
	0920	-					-	-	-	-	25000
	0930	10					127	122	+0.15	3	
	0940	20					129	125	+0.15	3	
	0950	30					129	126	+0.15	3	↑
	0950	-					-	-	-	-	30000
	1000	10					163	152	0	0	
	1010	20					165	156	0	0	
	1020	30	↓	↓	↓		165	156	0	0	↓

TEST NO. 4 | BRG. NO 49 RETAINER A9Hg INT. CL 5 MILS BALL HOLE CL 1A MILS CAGE-LAND CL 15 MILS GROOVES NO.

DATE	TIME	AXIAL LOAD		RADIAL LOAD		BEARING TEMP		BEARING TORQUE		SPEED	REMARKS	
		READING	RUNNING	PSI	LBS	PSI	LBS	I.R.	O.R.	READING IN-OZ	RPM	
19-9-74	0800	-	43	75	0	0		88	-0.05	1	1500	
	0810	10						88	0	0		↓
	0820	-						-	-	-	10000	
	0820	10						88	+0.1	2		
	0830	20						88	+0.1	2		↓
	0830	-						-	-	-	15000	
	0840	-						92	+0.1	2		
	0850	10						93	+0.1	2		↓
	0850	20						-	-	-	20000	
	0850	-						102	0	0		
	0900	10						104	-0.05	1		
	0910	20						104	-0.05	1		
	0920	30						106	-0.05	1		
	0930	40						106	-0.05	1		↓
	0930	-						-	-	-	25000	
	0940	10						114	0	0		
	0950	20						115	0	0		
	1000	30						115	0	0		↓
	1000	-						-	-	-	30000	
	1010	10						136	+0.05	1		
	1020	20						148	+0.05	1		
↓	1030	30	↓	↓	↓	↓	↓	148	+0.05	1		↓
20-9-74	0755	-	43	75	8	25		90	-0.05	1	1500	
	0805	10						90	-0.05	1		↓
	0805	-						-	-	-	10000	
	0815	10						90	+0.05	1		
	0825	20						90	+0.05	1		↓
	0825	-						-	-	-	15000	
	0835	10						95	0	0		
	0845	20						97	0	0		
	0855	30						97	0	0		↓
	0855	-						-	-	-	20000	
	0905	10						106	0	0		
	0915	20						108	0	0		
	0925	30						108	0	0		↓
	0925	-						-	-	-	25000	
	0935	10						118	-0.05	1		
	0945	20						120	-0.05	1		
	0955	30						122	-0.1	2		
	1005	40						122	-0.1	2		↓
	1005	-						-	-	-	30000	
	1015	10						134	-0.3	7		
	1025	20						142	-0.3	7		
↓	1035	30	↓	↓	↓	↓	↓	142	-0.3	7		↓
2-10-74	0835	-	43	75	16	50		74	+0.15	3	1500	
	0845	10						74	+0.15	3		↓
	0845	-						-	-	-	10000	
	0855	10						76	+0.3	7		
	0905	20						76	+0.3	7		↓
	0905	-						-	-	-	15000	
	0915	10						83	+0.1	2		
	0925	20						84	+0.1	2		↓
	0925	-						-	-	-	20000	
	0935	10						95	+0.05	1		
	0945	20						96	+0.05	1		
	0955	30						96	+0.05	1		↓
	0955	-						-	-	-	25000	
	1005	10						104	+0.05	1		
	1015	20						106	+0.05	1		
	1025	30						106	+0.05	1		↓
	1025	-						-	-	-	30000	
	1035	10						117	+0.05	1		
	1045	20						124	+0.05	1		
↓	1055	30	↓	↓	↓	↓	↓	124	+0.05	1		↓
2-10-74	1255	-	43	75	24	75		74	+0.3	7	1500	
	1305	10						76	+0.3	7		
	1315	20						76				↓
	1315	-						-	-	-	10000	
	1325	10						78	+0.	7		
	1335	20						79	+0.	7		
↓	1345	30	↓	↓	↓	↓	↓	79	+0.	7		↓

TEST NO. 4 | BRG NO 49 | RETAINER A49 | INT. CL 5 MILS | BALL HOLE CL 10 MILS | CAGE LND CL 15 MILS | GROOVES NO.

DATE	TIME	READING	RUNNING	AXIAL LOAD PSI	RADIAL LOAD LBS	BEARING TEMP. PSI	BEARING TORQUE LBS	SPEED RPM	REMARKS
2-10-74	1345	-	-	45	75	24	75	-	-
	1355	10				84	+ 0.3	7	
	1405	20				87	+ 0.3	7	
	1415	30				87	+ 0.3	7	Y
	1425	-				-	-	-	20000
	1435	10				98	+ 0.2	4	
	1445	20				102	+ 0.2	4	
	1455	30				102	+ 0.2	4	Y
	1505	-				-	-	-	25000
	1515	10				120	+ 0.2	1	
	1525	20				114	+ 0.2	4	
	1535	30				114	+ 0.2	4	Y
	1545	-				-	-	-	30000
	1555	10				140	+ 0.2	4	
	1555	20				144	+ 0.2	4	
	1555	30				144	+ 0.2	4	Y
	1555	-				-	-	-	35000
	1555	5				140	+ 0.2	4	
	1555	15				144	+ 0.2	4	
	1555	25				144	+ 0.2	4	Y
3-10-74	0750	-	-	67	150	8	25	72	+ 0.1
	0800	10				80	+ 0.1	2	7500
	0810	20				80	+ 0.1	2	
	0810	-				-	-	-	10000
	0820	10				86	+ 0.2	4	
	0830	20				86	+ 0.2	4	Y
	0830	-				-	-	-	15000
	0840	10				92	+ 0.1	2	
	0850	20				92	+ 0.1	2	Y
	0850	-				-	-	-	20000
	0900	10				101	0	0	
	0910	20				102	+ 0.1	2	
	0920	30				102	+ 0.1	2	
	0920	-				-	-	-	25000
	0930	10				121	+ 0.05	1	
	0940	20				126	+ 0.05	1	
	1000	40				128	+ 0.05	1	
	1010	50				128	+ 0.05	1	
	1020	-				-	-	-	30000
	1020	10				144	0	0	
	1030	20				146	0	0	
	1040	30				146	0	0	
3-10-74	1250	-	-	67	150	16	50	88	+ 0.25
	1300	10				89	+ 0.25	5	7500
	1300	-				-	-	-	
	1310	10				93	+ 0.2	4	
	1320	20				93	+ 0.2	4	
	1320	-				-	-	-	15000
	1330	10				100	+ 0.2	4	
	1340	20				102	+ 0.2	4	
	1350	30				102	+ 0.2	4	
	1350	-				-	-	-	20000
	1400	10				107	+ 0.1	2	
	1410	20				109	+ 0.1	2	
	1420	30				109			
	1420	-				-	-	-	25000
	1430	10				124	+ 0.15	3	
	1440	20				128	+ 0.15	3	
	1450	30				128	+ 0.15	3	
	1450	-				-	-	-	30000
	1500	10				148	+ 0.1	2	
	1510	20				150	+ 0.1	2	
	1520	30				150	+ 0.1	2	
4-10-74	0830	-	-	67	150	24	75	-	-
	0840	10				93	+ 0.2	4	
	0850	20				92	+ 0.2	4	
	0850	-				-	-	-	10000
	0900	10				93	+ 0.3	7	
	0910	20				93	+ 0.3	7	
	0910	-				-	-	-	15000
	0920	10				99	+ 0.2	4	
	0930	20				102	+ 0.2	4	
	0940	30				102	+ 0.2	4	
	0940	-				-	-	-	20000

TEST NO. 4 BRG. NO 49 RETAINER AqHg INT. CL 5 MILS BALLHOLE CL 10 MILS CAGE L AND CL 15 MILS GROOVES NO.

TIME	AXIAL LOAD	RADIAL LOAD	BEARING TEMP.	BEARING TORQUE	SPEED	REMARKS					
DATE	READING	PSI	LBS	PSI	LBS	I.R.	O.R.	READING	IN-OZ	RPM	
4-10-74	0954	10	67	150	24	75		112	+0.15	3	20000
	1000	20						114	+0.15	3	
	1010	30						114	+0.15	3	↓
	1010	-						-	-	-	25000
	1020	10						124	+0.15	3	
	1030	20						129	+0.15	3	
	1040	30						132	+0.15	3	
	1050	40						132	+0.15	3	↓
	1050	-						-	-	-	30000
	1100	10						148	+0.1	2	
	1110	20						154	+0.1	2	
	1120	30						155	+0.1	2	
	1130	40						155	+0.1	2	↓
4-10-74	1300	-	59	175	0	0		86	-0.05	1	7500
	1310	10						86	-0.05	1	↓
	1310	-						-	-	-	10000
	1320	10						88	+0.05	1	
	1330	20						88	+0.05	1	↓
	1330	-						-	-	-	15000
	1340	10						99	-0.1	2	
	1350	20						100	-0.1	2	↓
	1350	-						-	-	-	20000
	1400	10						112	-0.2	4	
	1410	20						112	-0.2	4	↓
	1410	-						-	-	-	25000
	1420	10						122	-0.1	2	
	1430	20						126	-0.1	2	
	1440	30						126	-0.1	2	↓
	1440	-						-	-	-	30000
	1450	10						180	-0.2	4	
	1500	20						184	-0.2	4	
	1510	30						188	-0.2	4	↓

TEST NO. 5 | BRG. NO. 42 | RETAINER A9H | INT. CL. 5 MILS | BALL HOLE CL. 10 MILS | CAGE-LAND CL. 15 MILS | GROOVES 3 MILS

DATE	TIME	AXIAL LOAD		RADIAL LOAD		BEARING TEMP.		BEARING TORQUE		SPEED	REMARKS		
		READING	RUNNING	PSI	LBS	PSI	LBS	I.R.	O.R.	READING	IN-OZ	RPM	
21-8-74	0800	-		43	75	0	0	88	91	+0.3	7	7800	
	0810	10						84	90	+0.3	7		
	0815	15						84	90	+0.3	7	↓	
	0815	-						-	-	-	-	10000	
	0825	10						84	90	+0.4	8.5		
	0835	20						84	90	+0.4	8.5	↓	
	0835	-						-	-	-	-	15000	
	0845	10						93	96	+0.2	4		
	0855	20						95	98	+0.1	2		
	0905	30						99	104	0	0		
	0915	40						102	106	-0.05	1	↓	
	0915	-						-	-	-	-	20000	
	0925	10						120	113	-0.05	1		
	0935	20						125	116	-0.1	2		
	0945	30						130	120	-0.05	1	↓	
	0945	-						-	-	-	-	25000	
	1000	15						154	134	-0.05	1		
	1010	25						155	138	-0.1	2		
	1120	35						157	140	-0.1	2	↓	
	1120	-						-	-	-	-	30000	
	1030	10						190	168	-0.1	2		
	1040	20						192	174	-0.1	2		
	1050	30	↓	↓	↓	↓	↓	193	174	-0.1	2	↓	
21-8-74	1300	-	51	100	0	0	0	91	93	+0.15	3	7500	
	1310	10						88	92	+0.2	4		
	1320	20						88	92	+0.2	4	↓	
	1320	-						-	-	-	-	10000	
	1330	10						88	92	+0.3	7		
	1340	20						88	92	+	↓		
	1340	-						-	-	-	-	15000	
	1350	10						98	97	+0.2	4		
	1400	20						102	100	+0.2	4		
	1410	30						102	102	+0.2	4	↓	
	1410	-						-	-	-	-	20000	
	1420	10						125	112	0	0		
	1430	20						129	116	+0.05	1		
	1440	30						129	117	+0.05	1	↓	
	1440	-						-	-	-	-	25000	
	1450	10						170	150	+0.05	1		
	1500	20						173	150	+0.1	2		
	1510	30						168	148	+0.1	2	↓	
	1510	-						-	-	-	-	30000	
	1520	10						197	164	-0.05	1		
	1530	20						203	160	-0.05	1	↓	
	1540	30	↓	↓	↓	↓	↓	204	160	-0.05	1	↓	
3-9-74	0805	-	59	125	0	0	0	83	88	+0.15	3	7500	
	0815	10						82	98	+0.2	4		
	0825	20						81	86	+0.15	3	↓	
	0825	-						-	-	-	-	10000	
	0830	5						81	86	+0.35	7.5		
	0840	15						82	86	+0.35	7.5	↓	
	0840	-						-	-	-	-	15000	
	0850	10						91	90	+0.2	4		
	0900	20						91	92	+0.2	4		
	0910	30						91	92	+0.2	4	↓	
	0910	-						-	-	-	-	20000	
	0920	10						105	99	+0.15	3		
	0930	20						106	101	+0.15	3		
	0940	30						106	102	+0.2	4		
	0950	40						106	102	+0.4	8.5	↓	
	0950	-						-	-	-	-	25000	
	0955	5						-	-	-	-		
	1000	10						122	110	+0.2	4		
	1010	20						124	114	+0.2	4		
	1020	30						126	116	+0.2	4		
	1030	40						127	116	+0.2	4	↓	
	1030	-						-	-	-	-	30000	
	1040	10						150	132	+0.05	1		
	1050	20						154	138	0	0		
	1100	30						157	140	+0.05	1		

TEST NO. 5 | BRG. NO. 42 RETHINER Ag/Hg | INT. CL. 5 MILS | BALL HOLE CL. 10 MILS | GAGE LAND CL. 15 MILS | GREYES 3 MILS

TIME	AXIAL LOAD	RADIAL LOAD	BEARING TEMP.	BEARING TORQUE	SPEED	REMARKS					
DATE	READING	RUNNING	PSI	LBS	PSI	LBS	I.R.	O.R.	READING	IN-OZ	RPM
3.9.74	1100	40	59	125	0	0	158	144	-0.05	1	30000
	1120	50					159	144	-0.05	1	
3.9.74	1300	-	67	150	0	0	88	88	-0.2	4	7500
	1310	10					80	88	-0.2	4	
	1320	20					78	87	-0.2	4	
	1330	-					-	-	-	-	10000
	1340	10					81	87	-0.15	3	
	1340	80					81	87	-0.15	3	
	1340	-					-	-	-	-	15000
	1350	10					89	87	-0.2	4	
	1400	20					89	87	-0.2	4	
	1400	-					-	-	-	-	20000
	1410	10					105	102	-0.35	7.5	
	1420	20					107	104	-0.30	7	
	1430	30					108	105	-0.35	7.5	
	1440	40					108	105	-0.35	7.5	
	1450	-					-	-	-	-	25000
	1450	10					128	112	-0.35	7.5	
	1500	20					130	118	-0.35	7.5	
	1510	30					130	120	-0.35	7.5	
	1520	-					-	-	-	-	30000
	1520	10					155	136	-0.45	10	
	1530	20					156	136	-0.5	11	
	1540	30					156	136	-0.5	11	
4.9.74	0800	-	43	75	8	25	88	90	-0.3	7	7500
	0810	10					85	90	-0.3	7	
	0820	20					83	88	-0.3	7	
	0830	-					-	-	-	-	10000
	0830	10					86	90	-0.2	4	
	0840	20					85	88	-0.15	3	
	0840	-					-	-	-	-	15000
	0850	10					93	92	-0.3	7	
	0850	20					93	92	-0.3	7	
	0900	-					-	-	-	-	20000
	0910	10					103	100	-0.35	7.5	
	0920	20					105	102	-0.4	8.5	
	0930	30					106	104	-0.4	8.5	
	0940	40					105	104	-0.4	8.5	
	0940	-					-	-	-	-	25000
	0950	10					124	112	-0.4	8.5	
	1000	20					125	116	-0.4	8.5	
	1010	30					124	116	-0.4	8.5	
	1010	-					-	-	-	-	30000
	1020	10					146	134	-0.5	11	
	1030	20					148	139	-0.55	12	
	1040	30					150	141	-0.55	12	
	1050	40					150	141	-0.55	12	
4.9.74	1300	-	43	75	16	50	87	88	+0.05	1	7500
	1310	10					88	88	+0.05	1	
	1310	-					-	-	-	-	10000
	1320	10					90	94	+0.1	2	
	1330	20					89	94	+0.1	2	
	1330	-					-	-	-	-	15000
	1340	10					102	101	-0.05	1	
	1350	20					102	102	-0.1	2	
	1400	30					102	102	-0.1	2	
	1400	-					-	-	-	-	20000
	1410	10					112	111	-0.25	5	
	1420	20					118	117	-0.2	4	
	1430	30					118	113	-0.2	4	
	1430	-					-	-	-	-	25000
	1440	10					125	115	-0.15	3	
	1450	20					126	116	-0.15	3	
	1500	30					126	116	-0.15	3	
	1500	-					-	-	-	-	30000
	1510	10					153	140	-0.2	4	
	1520	20					156	146	-0.2	4	
	1530	30					156	146	-0.2	4	
5.9.74	0830	-	43	75	24	75	89	94	+0.15	3	7500
	0840	10					88	94	+0.15	3	

TEST NO. 5 BRG. NO. 42, RETAINER AqHg INT. CL 5 MILS DALL HOLE CL 1/8 MILS GAGE LAND CL 1/8 MILS GRDYES 3 MILS

DATE	TIME	AXIAL LOAD		RADIAL LOAD		BEARING TEMP.		BEARING TORQUE		SPEED	REMARKS	
		READING	RUNNING	PSI	LBS	PSI	LBS	I.R.	O.R.	READING	IN-OZ	RPM
5-9-74	0840	-	43	75	24	75	-	-	-	-	10000	
	0850	10					93	88	+0.2	4		
	0900	20					93	88	+0.2	4		
	0900	-					-	-	-	-	15000	
	0910	10					103	104	+0.1	2		
	0920	20					103	103	+0.1	2		
	0920	-					-	-	-	-	20000	
	0930	10					120	111	0	0		
	0940	20					123	118	0	0		
	0950	30					123	118	0	0		
	0950	-					-	-	-	-	25000	
	1000	10					128	120	-0.05	1		
	1010	20					128	120	-0.05	1		
	1020	30					128	120	-0.05	1		
	1020	-					-	-	-	-	30000	
	1030	10					152	142	-0.1	2		
	1040	20					153	146	-0.05	1		
	1050	30					152	146	-0.05	1		
	V 1050	-					-	-	-	-	25000	
5-9-74	1200	-	51	100	9	25	82	86	-0.2	4	7500	
	1310	10					82	86	-0.2	4		
	1310	-					-	-	-	-	10000	
	1320	10					82	87	-0.05	1		
	1330	20					84	88	-0.05	1		
	1340	30					85	88	-0.05	1		
	1340	-					-	-	-	-	15000	
	1345	5					98	96	-0.05	1		
	1350	10					98	98	-0.05	1		
	1350	-					-	-	-	-	20000	
	1400	10					108	104	+1.2	27.5		questionable reading high fluctuation
	1410	20					110	105	+0.4	8.5		
	1420	30					110	105	+0.6	12.5		
	1420	-					-	-	-	-	25000	
	1430	10					126	114	-1.4	27.5		
	1440	20					127	116	-1.2	27.5		
	1450	30					127	116	-1.4	31.5		
	1450	-					-	-	-	-	30000	
	1500	10					160	142	-0.1	2		
	1510	20					164	148	-0.1	2		
	1520	30					164	148	-0.1	2		
	V 1520	-					-	-	-	-	25000	
6-9-74	0800	-	51	100	16	50	89	94	+0.2	4	7500	
	0810	10					8	94	+0.2	4		
	0810	-					-	-	-	-	10000	
	0820	10					92	96	+0.3	7		
	0830	20					92	96				
	0830	-					-	-	-	-	15000	
	0840	10					104	104	+0.2	4		
	0850	20					104	106	+0.2	4		
	0900	30					104	106	+0.2	4		
	0900	-					-	-	-	-	20000	
	0910	10					118	114	+0.1	2		
	0920	20					119	115	+0.1	2		
	0930	30					118	114	+0.1	2		
	0930	-					-	-	-	-	25000	
	0935	5					124	115	+0.2	4		
	0945	15					128	118	+0.2	4		
	0955	25					128	118	+0.2	4		
	0955	-					-	-	-	-	30000	
	1005	10					158	144	+0.15	3		
	1015	20					162	148	+0.15	3		
	V 1025	30					162	149	+0.15	3		
10-9-74	0810	-	51	100	24	75	93	98	+0.11	2	7500	
	0820	10					91	98	+0.1	2		
	0830	20					89	98	+0.1	2		
	0830	-					-	-	-	-	10000	
	0840	10					94	102	+0.15	3		
	0850	20					94	102	+0.15	3		
	0850	-					-	-	-	-	15000	
	0900	10					104	107	+0.05	1		
	0910	20					104	107	+0.05	1		
	V 0910	-					-	-	-	-	20000	

TEST NO. 5 BRG. NO. 42 RETAINER A<sub>9</sub>H<sub>9</sub> INT CL 5 MILS BALL HOLE CL 10 MILS GAGE LAND CL 15 MILS GROOVES 3 MILS

DATE	TIME	READING	RUNNING	AXIAL LOAD PSI	RADIAL LOAD LBS	PSI	LEGS	I.R.	O.R.	BEARING TEMP. READING	BEARING TORQUE IN-OZ	SPEED RPM	REMARKS
10-9-74	0920	10	56	100	24	75		112	114	-0.05	1	20000	
	0930	20						113	116	-0.05	1		
	0940	30						113	116	-0.05	1		
	0940	-						-	-	-	-	25000	
	0950	10						127	121	0	0		
	1000	20						127	121	0	0		
	1010	30						127	123	0	0		
	1010	-						-	-	-	-	30000	
	1020	10						146	136	-0.05	1		
	1030	20						149	142	-0.05	1		
	1040	30						149	142	-0.05	1		
	1040	-						-	-	-	-	25000	
9-9-74	0745	-	67	150	8	25		94	96	+0.3	7	7500	
	0755	10						95	97	+0.35	7.5		
	0805	20						88	80	+0.3	7		
	0805	-						-	-	-	-	10000	
	0815	10						92	100	+0.4	8.5		
	0825	20						91	88	+0.4	8.5		
	0825	-						-	-	-	-	15000	
	0835	10						97	103	+0.3	7		
	0845	20						96	102	+0.3	7		
	0845	-						-	-	-	-	20000	
	0855	10						111	110	+0.3	7		
	0905	20						111	111	+0.3	7		
	0905	-						-	-	-	-	25000	
	0915	10						130	120	+0.3	7		
	0925	20						131	124	+0.3	7		
	0935	30						133	125	+0.3	7		
	0945	40						133	126	+0.3	7		
	0955	50						133	126	+0.3	7		
	0955	-						-	-	-	-	30000	
	1005	10						158	182	+0.2	4		
	1015	20						162	148	+0.2	4		
	1025	30						164	150	+0.2	4		
	1035	40						164	150	+0.2	4		
	1035	-						-	-	-	-	25000	
9-9-74	1300	-	67	150	16	50		91	97	+0.1	2	7500	
	1310	10						88	97	+0.1	2		
	1310	-						-	-	-	-	10000	
	1320	10						90	99	+0.25	5		
	1330	20						90	98	+0.25	5		
	1330	-						-	-	-	-	15000	
	1340	10						92	101	+0.1	2		
	1350	20						97	101	+0.1	2		
	1350	-						-	-	-	-	20000	
	1400	10						113	110	+0.05	1		
	1410	20						114	112	0	0		
	1420	30						114	113	0	0		
	1420	-						-	-	-	-	25000	
	1430	10						131	122	+0.1	2		
	1440	20						134	126	+0.1	2		
	1450	30						134	126	+0.1	2		
	1450	-						-	-	-	-	30000	
	1500	10						160	146	0	0		
	1510	20						162	148	0	0		
	1520	30						162	148	0	0		
	1520	-						-	-	-	-	25000	
10-9-74	1250	-	67	150	24	75		90	98	+0.25	5	7500	
	1300	10						87	96	+0.3	7		
	1310	20						84	94	+0.3	7		
	1310	-						-	-	-	-	10000	
	1320	10						88	94	+0.4	8.5		
	1330	20						88	96	+0.4	8.5		
	1330	-						-	-	-	-	15000	
	1340	10						98	101	+0.25	5		
	1350	20						98	102	+0.25	5		
	1350	-						-	-	-	-	20000	
	1400	10						114	110	+0.2	4		
	1410	20						121	117	+0.15	3		
	1420	30						121	117	+0.15	3		
	1420	-						-	-	-	-	25000	
	1430	10						133	125	+0.25	5		
	1440	20						135	126	+0.25	5		

TEST NO. 5 BRG. NO. 42. RETAINER Agg. INT. CL. 5 MILS BALE HOLE CL. 18 MILS GAGE LIND CL. 15 MILS GREECS 3 MILS

TIME	AXIAL LOAD		RADIAL LOAD		BEARING TEMP.		BEARING TORQUE		SPEED	REMARKS	
DATE	READING	RUNNING	PSI	LBS	PSI	LBS	I.R.	O.R.	READING	IN-OZ	RPM
10-9-74	1450	30	67	150	24	75	136	127	+0.2	4	25000
	1450	-					-	-	-	-	30000
	1500	10					162	146	+0.2	4	
	1510	20					163	148	+0.2	4	
	1520	30					165	151	+0.2	4	
	1530	40					166	151	+0.2	4	

TEST NO. 6 BRG. NO 23 RETAINER W/GI INT. CL. 10 MILS BALL HOLE CL 17 MILS GAGE LAND CL 22 MILS GROOVES NO

DATE	TIME	AXIAL LOAD PSI	RADIAL LOAD LBS	BEARING TEMP. I.R. O.R.	BEARING TORQUE IN-OZ	SPEED RPM	REMARKS
16-9-74	1250	-	43	75	0	0	93 96 -0.05 1 2500
	1300	10					93 95 -0.05 1 ↓
	1300						- - - 10000
	1310	10					128 118 -0.05 1
	1320	20					103 116 0 0
	1330	30					103 112
	1330						- - - 15000
	1335	5					119 116 -0.05 1
	1345	15					118 115 -0.05 1
	1355						- - - 20000
	1355	10					128 116 -0.05 1
	1405	20					128 117 -0.05 1
	1415	30					128 117 -0.05 1 ↓
	1415						- - - 25000
	1425	10					148 130 -0.15 3
	1435	20					150 134 -0.15 3
	1445	30					153 136 -0.15 3
	1450	35					153 136 -0.15 3 ↓
	1450						- - - 30000
	1500	10					258 192 -0.3 7
	1510	20					232 193 -0.3 7
	1520	30					266 212 -0.4 8.5
	1530	40					265 212 -0.3 7 ↓
17-9-74	0900	-	51	100	0	0	99 98 -0.3 7 7500
	0910	10					100 100 -0.3 7
	0920	20					100 100 -0.3 7 ↓
	0920						- - - 10000
	0930	10					114 108 -0.25 5
	0940	20					119 113 -0.25 5
	0950	30					119 114 -0.25 5 ↓
	0950						- - - 15000
	1000	10					133 124 -0.2 4
	1010	20					132 130 -0.1 2
	1020	30					133 129
	1020						- - - 20000
	1030	10					146 132 -0.2 4
	1040	20					148 132 -0.2 4
	1050	30					148 130 -0.2 4
	1100	40					160 132 -0.2 4
	1110	50					160 131 +0.1 2 ↓
	1110						- - - 25000
	1120	10					176 148 -0.25 5
	1130	20					178 146 -0.25 5
	1140	30					188 156 -0.3 7 ↓
	1140						- - - 30000
	1150	10					232 190 -0.3 7
	1160	20					257 216 -0.3 7
	1210	30					256 216 -0.3 7 ↓
17-9-74	1255	-	59	125	0	0	94 97 -0.05 1 7500
	1305	10					94 97 +0.05 1 ↓
	1305						- - - 10000
	1315	10					100 100 +0.05 1
	1325	10					95 98 +0.05 1
	1335	30					94 98 +0.05 1 ↓
	1335						- - - 15000
	1345	10					219 186 -0.2 4
	1355	20					219 186 -0.2 4
	1405	30					192 172 -0.2

## TEST NO. 7 BRG. NO. 32 RETAINER VGI INT. CL 10 MILS BALL HOLE CL 17 MILS CAGE-LAND CL 22 MILS GROOVES NO.

DATE	TIME	AXIAL LOAD PSI	RADIAL LOAD LBS	BEARING TEMP. °R	BEARING TORQUE IN-OZ	SPEED RPM	REMARKS			
	READING	RUNNING	PSI	LBS	I.R.	O.R.	READING	IN-OZ	RPM	
2-10-74	1250	-	43	75	0	0	85	-0.1	2	7500
	1300	10					88	-0.1	2	
	1310	20					86	-0.1	2	↓
	1310	-					-	-	-	10000
	1320	10					92	-0.05	1	
	1330	20					92	-0.05	1	↓
	1330	-					-	-	-	15000
	1340	10					102	-0.8	7	
	1350	20					105	-0.3	7	
	1400	30					105	-0.3	7	
	1410	40					105	-0.3	7	↓
	1410	-					-	-	-	20000
	1420	20					112	+0.1	2	
	1440	30					112	+0.1	2	↑
	1440	-					-	-	-	25000
	1450	10					118	-0.4	85	
	1500	20					122	-0.4	85	
	1510	30					122	-0.4	85	↑
	1510	-					-	-	-	30000
	1520	10					Failure	Wear on ball pocket sides		

## TEST NO. 8 BRG. NO. 32 RETAINER VGI INT. CL 10 MILS BALL HOLE CL 17 MILS CAGE-LAND CL 22 MILS GROOVES NO.

2-10-74	1250	-	43	75	0	0	102	-0.05	1	7500
	1300	10					102	-0.05	1	↓
	1300	-					-	-	-	10000
	1310	10					112	+0.1	2	
	1320	20					112	+0.1	2	↓
	1320	-					-	-	-	15000
	1330	10					13.8	-0.2	4	
	1340	20					148	-0.2	4	
	1350	30					148	-0.2	4	↓
	1350	-					-	-	-	20000
	1400	10					178	-0.2	4	
	1400	-					178	-0.2	4	↓
	1410	10					196	-0.2	4	
	1420	20					200	-0.2	4	
	1430	30					200	-0.2	4	↑
	1430	-					-	-	-	30000
	1440	10					Failure	-		

## TEST NO. 9 BRG. NO. 27 RETAINER VGI INT. CL 10 MILS BALL HOLE CL 17 MILS CAGE-LAND CL 17 MILS GROOVES NO.

9-10-74	0750	-	43	75	0	0	82	0.05	1	7500
	0800	10					82	0.05	1	↓
	0800	-					-	-	-	10000
	0810	10					84	0.1	2	
	0820	20					86	0.1	2	
	0830	-					86	-	-	↓
	0830	-					-	-	-	15000
	0840	10					92	0.15	3	
	0850	20					98	0.2	4	
	0900	30					98	0.2	4	↓
	0900	-					-	-	-	20000
	0910	10					98	0.15	3	
	0920	20					98	0.2	4	
	0930	30					99	0.2	4	↑
	0930	-					-	-	-	25000
	0940	10					104	0.2	4	
	0940	20					103	0.2	4	↓
	0950	-					-	-	-	30000
	1000	10					109	0.2	4	Torque erratic
	1010	20					123	0.05	1	↓
	1020	30					122	0.05	1	Failure-Ball-Shroud Contact

TEST NO. 10 BRG. NO 1 RETAINER W/GZ INT CL 10 MILS BALL HOLE CL 17 MILS CAGE LAND CL 22 MILS GROOVES 1MA

DATE	TIME READING	AXIAL LOAD		RADIAL LOAD		BEARING TEMP. I.R.	BEARING TORQUE READING IN-OZ	SPEED RPM	REMARKS
		PSI	LBS	PSI	LBS				
0810	-	43	75	0	0	82	0.05	1.	7500
0830	10					84	0.1	2	
0840	20					84	0.1	2	↓
0840	-					-	-	-	10000
0850	10					92	0.15	3	
0900	20					92	0.15	3	↓
0900	-					-	-	-	15000
0910	10					95	0.15	3	
0920	20					95	0.15	3	↓
0920	-					-	-	-	20000
0930	10					98	0.2	4	
0940	20					106	0.2	4	
0950	30					106	0.2	4	↓
0950	-					-	-	-	25000
1000	10					109	0.2	4	
1010	20					115	0.2	4	
1020	30					115	0.2	4	↓
1020	-					-	-	-	30000
1030	10					118	0.4	8.5	
1040	20					150	0.4	8.5	Evidence of cage
1050	90	↓	↓	↓	↓	150	0.4	8.5	unbalance

TEST NO. 11 BRG NO 24 RETAINER Ag<sub>9</sub> INT. CL 10 MILS BALL HOLE CL 17 MILS GAGE LINDCL 22 MILS GREYES NO

DATE	TIME	AXIAL LOAD PSI	RADIAL LOAD PSI	BEARING TEMP. I.R. O.R.	BEARING TORQUE READING IN-OZ	SPEED RPM	REMARKS
11-12-74	0845	-	43	75	0	0	
	0855	10					
	0855	-					
	0905	10					
	0915	20					
	0915	-					
	0925	10					
	0935	20					
	0945	30					
	0945	-					
	0955	10					
	1005	20					
	1015	30					
	1025	-					
	1025	10					
	1035	20					
	1045	30					
	1045	-					
	1055	10					
	1105	20					
	1115	30					
	1115	-					
11-12-74	1300	-	51	100	0	0	
	1310	10					
	1310	-					
	1320	10					
	1330	20					
	1330	-					
	1340	10					
	1350	20					
	1400	30					
	1400	-					
	1410	10					
	1420	20					
	1430	30					
	1440	40					
	1440	-					
	1450	10					
	1500	20					
	1510	30					
	1510	-					
	1520	10					
	1530	20					
	1540	30					
	1540	-					
12-12-74	0750	-	59	125	0	0	
	0800	10					
	0810	20					
	0810	-					
	0820	10					
	0830	20					
	0830	-					
	0840	10					
	0850	20					
	0850	30					
	0850	-					
	0900	10					
	0910	20					
	0920	30					
	0930	40					
	0930	-					
	0940	10					
	0950	20					
	1000	30					
	1000	-					
	1010	10					
	1020	20					
	1030	30					
	1030	-					
13-12-74	1045	-	67	150	0	0	
	1055	10					
	1055	-					
	1105	10					
	1115	20					

TEST NO. 11 BRG. NO 24 RETAINER AND INT. CL 10 MILS BALL HOLE CL 17 MILS GAGE LAND CL 22 MILS GROOVES NO.

DATE	TIME	AXIAL LOAD PSI	RADIAL LOAD LBS	BEARING TEMP. O.R.	BEARING TORQUE IN-OZ	SPEED RPM	REMARKS
	READING	RUNNING	PSI	LBS	O.R.	READING	
13-12-74	1315	-	67	150	0	-	15000
	1325	10				96	0.45
	1335	20				104	0.3
	1345	30				104	0.3
	1348	-				-	-
	1355	10				122	0.3
	1405	20				124	0.3
	1408	-				-	-
	1415	10				132	0.35
	1425	20				135	0.4
	1435	30				138	0.35
	1440	35				138	0.35
	1440	-				-	-
	1445	5				147	0.4
	1455	15				150	0.4
	1505	25				152	0.4
	1515	35				152	0.4
16-12-74	0810	-	43	75	8	25	84 0.05 1 2500
	0820	10				84	0 0
	0820	-				-	-
	0830	10				84	0.05 1
	0840	20				85	0.05 1
	0850	30				85	0.05 1
	0850	-				-	-
	0900	10				97	0.1 2
	0910	20				100	0.1 2
	0920	30				100	0.1 2
	0930	-				-	-
	0940	10				108	0.15 3
	0940	20				111	0.15 3
	0950	30				111	0.15 3
	0950	-				-	-
	1000	10				126	0.2 4
	1010	20				130	0.2 4
	1020	30				130	0.2 4
	1020	-				-	-
	1030	10				148	0.4 8.5
	1040	20				152	0.4 8.5
	1050	30				154	0.4 8.5
16-12-74	1245	-	43	75	16	50	87 0.05 1 2500
	1255	10				87	0.05 1
	1255	-				-	-
	1305	10				88	0.2 4
	1315	20				88	0.2 4
	1315	-				-	-
	1325	10				92	0.25 5
	1335	20				102	0.25 5
	1345	30				102	0.25 5
	1345	-				-	-
	1355	10				116	0.3 7
	1405	20				120	0.3 7
	1415	30				122	0.25 5
	1425	40				122	0.25 5
	1435	-				-	-
	1435	10				132	0.35 7.5
	1445	20				140	0.35 7.5
	1455	30				140	0.35 7.5
	1455	-				-	-
	1505	10				152	0.5 11
	1515	20				164	0.5 11
	1525	30				165	0.5 11
17-12-74	0740	-	43	75	24	75	88 0.05 1 2500
	0750	10				88	0.05 1
	0750	-				-	-
	0800	10				89	0.1 2
	0810	20				89	0.1 2
	0820	30				-	-
	0830	20				100	0.15 3
	0840	30				104	0.15 3
	0840	-				104	0.15 3

TEST NO. 11 | BRG. NO 24 | RETAINER Agg | INT. CL 10 MILS | BALL HOLE CL 17 MILS | GAGE LAND CL 22 MILS | GROOVES NO.

DATE	TIME	AXIAL LOAD READING PSI	RADIAL LOAD READING LBS	BEARING TEMP. I.R. O.R. READING	BEARING TORQUE IN-OZ	SPEED RPM	REMARKS
17-12-74	0840	-	43	75	24	75	
	0850	10			118	0.2	4
	0860	20			124	0.2	4
	0870	30			127	0.2	4
	0880	40			127	0.2	4
	0890	-			-	-	20000
	0900	10			138	0.25	5
	0910	20			144	0.25	5
	0920	30			148	-	↓
	0930	-			-	-	25000
	0940	10			172	0.3	7
	0950	20			177	0.3	7
	0950	30			177	0.3	7
	0950	-			-	-	30000
	1000	10			172	0.3	7
	1010	20			177	0.3	7
	1020	30	↓	↓	177	0.3	7
	1020	-	↓	↓	177	0.3	7
17-12-74	1245	-	51	100	8	25	
	1255	10			88	0.1	2
	1255	-			88	0.1	2
	1305	10			-	-	10000
	1315	20			90	0.1	2
	1315	-			90	0.1	2
	1325	10			-	-	15000
	1335	20			103	0.2	4
	1335	-			103	0.2	4
	1345	10			-	-	20000
	1345	20			116	0.3	7
	1345	-			120	0.3	7
	1405	30			124	0.3	7
	1415	40			124	0.3	7
	1415	-			-	-	25000
	1425	10			134	0.35	7.5
	1435	20			150	0.4	8.5
	1445	30			160	0.4	8.5
	1455	40			160	0.4	8.5
	1455	-			-	-	30000
	1505	10			163	0.45	10
	1515	20			164	0.45	10
	1525	30	↓	↓	164	0.45	10
	1525	-	↓	↓	164	0.45	10
18-12-74	0750	-	51	100	16	50	
	0800	10			88	0.1	2
	0800	-			88	0.1	2
	0810	10			-	-	10000
	0820	20			96	0.15	3
	0820	-			97	0.15	3
	0830	10			-	-	15000
	0840	20			100	0.25	5
	0850	30			108	0.25	5
	0850	-			108	0.25	5
	0860	10			-	-	20000
	0910	20			129	0.35	7.5
	0920	30			135	0.35	7.5
	0920	-			136	0.35	7.5
	0920	10			-	-	25000
	0930	20			139	0.35	7.5
	0940	30			141	0.35	7.5
	0950	-			141	0.35	7.5
	0950	10			-	-	30000
	1000	20			154	0.5	11
	1010	30	↓	↓	162	0.5	11
	1020	-	↓	↓	162	0.5	11
18-12-74	1250	-	51	100	24	75	
	1300	10			84	0.2	4
	1300	-			84	0.2	4
	1320	10			-	-	10000
	1320	20			88	0.25	5
	1320	-			88	0.25	5
	1330	10			-	-	15000
	1340	20			104	0.3	7
	1340	-			104	0.3	7
	1350	10			-	-	20000
	1350	20			116	0.35	7.5
	1360	-			121	0.35	7.5
	1410	30			126	0.35	7.5
	1420	40			126	0.35	7.5
	1420	-			-	-	25000

TEST NO. 11 BRG. NO 24 RETAINER ANG INT. CL 10 MILS BALL HOLE CL 17 MILS GAGE LAND CL 22 MILS GROOVES NO.

	TIME	AXIAL LOAD		RADIAL LOAD		BEARING TEMP.	BEARING TORQUE		SPEED	REMARKS
DATE	READING	RUNNING	PSI	LBS	PSI	LBS	I.R.	O.R.	READING IN-OZ	RPM
8-12-74	1430	10	51	600	24	75	136	0.4	85	25000
	1440	20					146	0.4	85	
	1450	30					146	0.4	8.5	↓
	1450	-					-	-	-	30000
	1500	10					169	0.5	11	
	1510	20					180	0.5	11	
	1520	30					180	0.5	11	↓
8-12-74	0745	-	67	150	8	25	88	0.1	2	7500
	0755	10					88	0.1	2	↓
	0755	-					-	-	-	10000
	0805	10					94	0.1	2	
	0815	20					98	0.1	2	↓
	0815	-					-	-	-	15000
	0825	10					106	0.15	3	
	0835	20					110	0.15	3	
	0845	30					110	0.15	3	↓
	0845	-					-	-	-	20000
	0855	10					138	0.2	4	
	0855	20					145	0.2	4	
	0915	30					148	0.2	4	
	0925	40					148	0.2	4	↓
	0925	-					-	-	-	25000
	0935	10					159	0.25	5	
	0945	20					163	0.25	5	
	0955	30					163	0.25	5	↓
	0955	-					-	-	-	30000
	1005	10					184	0.25	5	
	1015	20					186	0.25	5	
	1025	30					184	0.25	5	↓
8-1-75	0745	-	67	150	16	50	92	0.1	2	7500
	0755	10					92	0.1	2	↓
	0755	-					-	-	-	10000
	0805	10					98	0.15	3	
	0815	20					98	0.15	3	↓
	0815	-					-	-	-	15000
	0825	10					108	0.25	5	
	0835	20					116	0.25	5	
	0845	30					116	0.25	5	↓
	0845	-					-	-	-	20000
	0855	10					138	0.3	7	
	0855	20					144	0.3	7	
	0915	30					150	0.3	7	
	0925	40					153	0.35	7.5	
	0925	50					158	0.4	8.5	
	0945	60					157	0.4	8.5	
	0950	65					159	0.4	8.5	
	1000	75					162	0.4	8.5	
	1010	85					162	0.4	8.5	↓
	1010	-					-	-	-	25000
	1020	10					178	0.45	10	
	1030	20					178	0.45	10	↓
	1030	-					-	-	-	30000
	1040	10					184	0.45	10	
	1050	20					184	0.45	10	↓
8-1-75	1255	-	67	150	24	25	92	0.05	1	7500
	1305	10					92	0.05	1	↓
	1305	-					-	-	-	10000
	1315	10					96	0.1	2	
	1325	20					96	0.1	2	↓
	1325	-					-	-	-	15000
	1335	10					107	0.15	3	
	1345	20					118	0.2	4	
	1355	30					114	0.2	4	↓
	1355	-					-	-	-	20000
	1405	10					184	0.25	5	
	1415	20					158	0.2	7	
	1425	30					162	0.3	7	
	1435	40					162	0.3	7	↓
	1445	-					-	-	-	25000
	1445	10					186	0.35	7.5	↓

TEST NO 11 BRG. NO 24 RETAINER RING INT. CL 10 MILS BALL HOLE CL 17 MILS CAGE LAND CL 22 MILS GRATES NO

DATE	TIME	AXIAL LOAD		RADIAL LOAD		BEARING TEMP.		BEARING TORQUE		SPEED	REMARKS	
		READING	RUNNING	PSI	LBS	PSI	LBS	I.R.	O.R.	READING	IN-OZ	RPM
2-1-78	1455	20	67	150	24	75	191	0.35	.75	25000		
	1505	90					191	0.35	7.5			↓
	1505	-					-	-	-	30000		
	1515	10					184	0.25	5			
	1525	20					182	0.25	5			
	1535	30					181	0.25	5			↓

TEST NO. 12 BRG. NO. 2 RETAINER AgHg INT. CL 10 MILS BALL HOLE CL 17 MILS CASE-LAND CL 22 MILS GROOVES 1 MIL

DATE	TIME	AXIAL LOAD		RADIAL LOAD		BEARING TEMP.	BEARING TORQUE	SPEED	REMARKS
		READING	RUNNING	PSI	LBS				
3-1-75	1250	-	43	75	0	0	84	0.2	4 7500
	1300	10					84	0.2	4 ↓
	1300	-					-	-	10000
	1310	10					89	0.25	5
	1320	20					89	0.25	5 ↓
	1320	-					-	-	15000
	1330	10					104	0.25	5
	1340	20					104	0.25	5 ↓
	1340	-					-	-	20000
	1350	10					118	0.2	8.5
	1400	20					128	0.2	8.5
	1410	30					136	0.2	8.5
	1420	40					147	0.2	8.5
	1430	50					147	0.2	8.5 ↓
	1430	-					-	-	25000
	1440	10	↓	↓	↓	↓	198	0.25	10 ↓
	1450	20	↓	↓	↓	↓			
									External Temperatures imbalance caused cage O.R. To contact bearing O.R. Cage 10 unnoted

TEST NO. 13 BRG. NO. 6 RETAINER AgHg INT. CL 10 MILS BALL HOLE CL 17 MILS CASE-LAND CL 22 MILS GROOVES 1 MIL

2-1-75	1250	-	43	75	0	0	86	0.05	1 7500
	1300	10					86	0.05	1 ↓
	1300	-					-	-	10000
	1310	10					88	0.1	2
	1320	20					88	0.1	2 ↓
	1320	-					-	-	15000
	1330	10					98	0.15	3
	1340	20					102	0.15	3
	1350	30					103	0.15	3 ↓
	1350	-					-	-	20000
	1400	10					124	0.2	4
	1410	20					124	0.2	4 ↓
	1410	-					-	-	25000
	1420	10					-	-	

TEST NO. 14 BRG. NO. 6 RETAINER AgHg INT. CL 10 MILS BALL HOLE CL 17 MILS CASE-LAND CL 26 MILS GROOVES 1 MIL

14-1-75	0755	-	43	75	0	0	81	0.05	1 7500
	0805	10					81	0.05	1 ↓
	0805	-					-	-	10000
	0815	10					83	0.1	2
	0825	20					83	0.1	2 ↓
	0835	-					-	-	15000
	0835	10					91	0.15	3
	0845	20					91	0.15	3 ↓
	0845	-					-	-	20000
	0855	10					98	0.2	4
	0905	20					102	0.2	4
	0915	30					103	0.2	4 ↓
	0915	-					-	-	25000
	0925	10					114	0.3	7
	0935	20					122	0.35	7.5
	0945	30					128	0.35	7.5
	0955	40					128	0.35	7.5 ↓
	0955	-					-	-	30000
	1005	10					146	0.45	10
	1015	20					152	0.45	10
	1015	-					-	-	
	1025	30	↓	↓	↓	↓	152	0.45	10 ↓
15-1-75	0750	-	51	100	0	0	87	0.05	1 7500
	0800	10					84	0.05	1 ↓
	0800	-					86	0.1	2
	0810	10					86	0.1	2 ↓
	0810	-					-	-	10000
	0820	10					93	0.2	4
	0830	20					97	0.2	4
	0840	30					97	0.2	4 ↓
	0850	-					-	-	20000
	0850	10					108	0.3	7
	0900	20					113	0.3	7
	0910	30					113	0.3	7

TEST NO 14 BRG. NO 6 [RETAINER AgMg INT. CL 10 MILS] BALL HOLE CL 17 MILS CAGE LAND CL 36 MILS SPACES/MIL											
DATE	TIME	AXIAL LOAD		RADIAL LOAD		BEARING TEMP.		BEARING TORQUE		SPEED	REMARKS
		READING	RUNNING	PSI	LBS	PSI	LBS	I.R.	O.R.	READING IN-OZ	RPM
15-1-75	0910	-	\$1	100	0	0	0	-	-	-	25000
	0920	10						123	0.4	85	
	0930	20						129	0.45	10	
	0940	30						132	0.45	10	
	0950	40						132	0.45	10	↓
	0950	-						-	-	-	30000
	1000	10						154	0.55	12	
	1010	20						155	0.55	12	
	1020	30						155	0.55	12	↓
15-1-75	1245	59	125	0	0	0	0	-	0.2	4	7500
	1255	10						89	0.2	4	
	1305	20						89	0.2	4	↓
	1315	-						-	-	-	10000
	1325	10						91	0.25	5	
	1335	20						91	0.25	5	↓
	1345	-						-	-	-	15000
	1355	10						98	0.35	7.5	
	1365	20						103	0.35	7.5	
	1375	30						103	0.35	7.5	↑
	1385	-						-	-	-	20000
	1405	10						106	0.4	85	
	1415	20						116	0.4	85	
	1425	30						116	0.4	85	↓
	1435	-						-	-	-	25000
	1445	10						128	0.5	11	
	1455	20						138	0.55	12	
	1465	30						138	0.55	12	↓
	1475	-						-	-	-	30000
	1485	10						144	0.6	13.5	
	1495	20						144	0.6	13.5	
	1505	30						144	0.6	13.5	↑
16-1-75	0745	-	67	150	0	0	0	86	0.2	4	7500
	0755	10						86	0.2	4	↓
	0755	-						-	-	-	10000
	0805	10						89	0.25	5	
	0815	20						89	0.25	5	↓
	0815	-						-	-	-	15000
	0825	10						94	0.4	85	
	0835	20						100	0.4	85	
	0845	30						100	0.4	85	↓
	0845	-						-	-	-	20000
	0855	10						117	0.5	11	
	0855	20						120	0.55	12	
	0915	30						120	0.55	12	↓
	0915	-						-	-	-	25000
	0925	10						122	0.6	13.5	
	0935	20						122	0.6	13.5	↓
	0935	-						-	-	-	30000
	0945	10						124	0.6	13.5	
	0955	20						130	0.6	13.5	
	1005	30						130	0.6	13.5	↑
16-1-75	1330	-	47	75	8	25	0	82	0.05	1	7500
	1340	10						82	0.05	1	↓
	1340	-						-	-	-	10000
	1350	10						84	0.1	2	
	1400	20						84	0.1	2	↓
	1400	-						-	-	-	15000
	1410	10						90	0.15	3	
	1420	20						94	0.15	3	
	1430	30						94	0.15	3	↓
	1430	-						-	-	-	20000
	1440	10						98	0.2	4	
	1450	20						98	0.2	4	↓
	1450	-						-	-	-	25000
	1500	10						104	0.2	4	
	1510	20						106	0.2	4	
	1520	30						106	0.2	4	↓
	1520	-						-	-	-	30000
	1530	10						116	0.3	7	
	1540	20						116	0.3	7	↑

TEST NO 14 BRG. NO 6 RETAINER A94 INT. CL 10 MILS BALL HOLE CL 17 MILS GAGE LAND CL 36 MILS GROOVES / MIL

TIME		AXIAL LOAD		RADIAL LOAD		BEARING TEMP.		BEARING TORQUE		SPEED	REMARKS	
DATE	READING	RUNNING	PSI	LBS	PSI	LBS	I.R.	O.R.	READING	IN-OZ	RPM	
16-1-75	1550	30	43	75	8	25			14	0.3	7	30000
17-1-75	0245	-	43	75	16	50			81	0.45	1	7500
	0255	10							81	0.45	1	↓
	0255	-							-	-	10000	
	0805	10							84	0.45	1	↓
	0815	20							84	0.45	1	↓
	0815	-							-	-	15000	
	0825	10							88	0.1	2	
	0835	20							90	0.1	2	
	0835	30							90	0.1	2	↓
	0845	-							-	-	20000	
	0855	10							96	0.15	3	
	0905	20							98	0.15	3	
	0915	30							98	0.15	3	↓
	0915	-							-	-	25000	
	0925	10							102	0.15	3	
	0935	20							106	0.15	3	
	0945	30							106	0.15	3	↓
	0945	-							-	-	30000	
	1005	10							120	0.25	5	
	1005	20							122	0.25	5	
	1015	30							122	0.25	5	↓
17-1-75	1445	-	43	75	24	75			84	0.45	1	7500
	1555	10							84	0.45	1	↓
	1555	-							-	-	10000	
	1605	10							86	0.1	2	
	1615	20							86	0.1	2	↓
	1615	-							-	-	15000	
	1625	10							88	0.1	2	
	1635	20							88	0.1	2	↓
	1635	-							-	-	20000	
	1645	10							96	0.15	3	
	1655	20							96	0.15	3	↓
	1655	-							-	-	25000	
	1705	10							98	0.15	3	
	1715	20							101	0.15	3	↓
	1725	30							101	0.15	3	↓
	1725	-							-	-	30000	
	1735	10							104	0.3	7	
	1745	20							116	0.4	8.5	
	1745	30							116	0.4	8.5	↓
18-1-75	1555	30	↓	↓	↓	↓			82	0.1	2	7500
	0750	-	51	100	8	25			82	0.1	2	↓
	0800	10							-	-	10000	
	0820	-							85	0.15	3	
	0820	10							85	0.15	3	
	0820	20							85	0.15	3	↓
	0820	-							-	-	15000	
	0830	10							90	0.2	4	
	0840	20							90	0.2	4	
	0850	30							90	0.2	4	↓
	0850	-							-	-	20000	
	0900	10							96	0.4	8.5	
	0910	20							100	0.4	8.5	
	0920	30							100	0.4	8.5	↓
	0920	-							-	-	25000	
	0930	10							102	0.4	8.5	
	0940	20							111	0.4	8.5	
	0950	30							111	0.6	13.5	↓
	0950	-							-	-	30000	
Y	1000	10										

## TEST NO. 15 - BRG. NO. 92 RETAINER W/GI INT. CL 5 MILS BALL-HOLE CL 17 MILS CAGE LAND CL 22 MILS GROOVES 3 MILS

DATE	TIME	AXIAL LOAD		RADIAL LOAD		BEARING TEMP		BEARING TORQUE		SPEED	REMARKS	
		READING	RUNNING	PSI	LBS	PSI	LBS	I.R.	O.R.	READING	NV-OZ	
8-1-75	0830	-	43	75	0	0	0	93	0.15	3	7500	
	0840	10						93	0.15	3		
	0840	-						-	-	-	10000	
	0850	10						100	0.2	4		
	0850	20						100	0.2	4		
	0900	-						-	-	-	15000	
	0910							112	0.2	4		
	0920	10						112	0.2	4		
	0920	20						-	-	-	20000	
	0930	-						128	0.25	5		
	0940	10						130	0.25	5		
	0950	30						130	0.25	5		
	0950	-						-	-	-	25000	
	1000	10						144	0.3	7		
	1010	20						146	0.3	7		
	1020	30						148	0.3	7		
	1020	-						-	-	-	30000	
	1030	10						210	0.3	7		
	1040	20						212	0.3	7		
	1050	30						212	0.3	7		
9-1-75	0750	-	51	100	0	0	0	96	0.05	1	7500	
	0800	10						96	0.05	1		
	0800	-						-	-	-	10000	
	0810	10						112	0.1	2		
	0820	20						112	0.1	2		
	0820	-						-	-	-	15000	
	0830	10						132	0.15	3		
	0840	20						132	0.15	3		
	0840	-						-	-	-	20000	
	0850	10						166	0.2	4		
	0850	20						174	0.2	4		
	0910	30						176	0.2	4		
	0920	40						176	0.2	4		
	0920	-						-	-	-	25000	
	0930	10						210	0.2	4		
	0940	20						212	0.2	4		
	0950	30						212	0.2	4		
	0950	-						-	-	-	30000	
	1010	10						288	0.2	4		
	1010	20						288	0.2	4		
	1020	30						288	0.2	4		
9-1-75	1045	-	59	12.5	0	0	0	130	0.2	4	7500	
	1055	10						130	0.2	4		
	1055	-						-	-	-	10000	
	1105	10						144	0.3	7		
	1310	15						144	0.3	7		
	1314	-						-	-	-	15000	
	1320	10						190	0.3	7		
	1330	20						190	0.3	7		
	1330	-						-	-	-	20000	
	1340	10						208	0.3	7		
	1350	20						208	0.3	7		
	1360	30						208	0.3	7		
	1400	-						-	-	-	25000	
	1410	10						26.5	0.35	7.5		
	1420	20						224	0.35	7.5		
	1430	30						279	0.3	2		
	1480	40						292	0.35	7.5		
	1450	50						292	0.35	7.5		
	1450	-						322			30000	

\* Run stopped due to high temperatures. Cage O.D. - outer race contact had occurred.

## TEST NO. 16 BRG. NO. 92 RETAINER HOT INT. CL 5 MILS BALL-HOLE CL 17 MILS CAGE LAND CL 22 MILS GROOVES 3 MILS

Upon initiation of this test series high torque readings of 3.5 were encountered. No. 2 bearing sleeve had rubbed against a carbon sleeve in the rig. Upon test instant torque readings of 630-640 were encountered at 7500 rpm. Upon reinspection it was found that the bearing races and ball tracks were quite rough indicating the bearing was defective to start with. The retainer looked good. This test failed.

TEST NO. 17 BRG. NO 22 RETAINER Ag/H INT CL 10 MILS DALL HOLE CL 10 MILS GAGE LAND CL 15 MILS GRADIES / MIL

TIME	AXIAL LOAD	RADIAL LOAD	BEARING TEMP.	BEARING TORQUE	SPEED	REMARKS				
DATE	READING	PSI	LBS	PSI	LBS	I.R.	O.R.	READING IN OZ	RPM	
20-3-75	1750	-	43	75	0	0	88	0.1	2	2500
	1760	19					88	0.1	3	↓
	1780	-					-	-	-	10000
	1790	10					92	0.1	2	↓
	1790	20					92	0.1	2	↓
	1790	-					-	-	-	15000
	1790	19					100	0.15	3	↓
	1790	20					100	0.15	3	↓
	1790	-					-	-	-	20000
	1790	10					112	0.2	4	↓
	1790	20					112	0.2	4	↓
	1790	-					-	-	-	25000
	1790	10					140	0.25	5	↓
	1790	20					146	0.25	5	↓
	1790	30					154	0.3	7	↓
	1790	40					158	0.3	7	↓
	1790	-					-	-	-	30000
	1790	10					Torque reading rose to 0.45 and temperature jumped to 200°F. Inspection showed Test bearing retainer nut had not been installed. Retainer had rubber on outer race but no metal. To metal contact.			
21-3-75	0840	-					90	0.05	1	7500
	0850	10					90	0.05	1	↓
	0850	-					-	-	-	10000
	0860	10					92	0.05	1	↓
	0870	20					92	0.05	1	↓
	0870	-					-	-	-	15000
	0870	10					102	0.15	3	↓
	0870	20					106	0.15	3	↓
	0870	30					106	0.15	3	↓
	0870	-					-	-	-	20000
	0880	10					121	0.2	4	↓
	0880	20					121	0.2	4	↓
	0880	-					-	-	-	25000
	0890	10					180	0.4	9.5	↓
	0890	20					204	0.45	10	↓
	0890	23					207	0.5	11	↓ unstable operation
										Inspection showed heavy rub on retainer I.D. probably as the result of unbalance

## TEST NO. 18 | BRG. NO. 50 | RETAINER W/LG | INT CL. 5 MILS | BALL HOLE CL. 10 MILS | GAGE LAND CL. 15 MILS | GROOVES NO.

DATE	TIME	AXIAL LOAD		RADIAL LOAD		BEARING TEMP	BEARING TORQUE	SPEED	REMARKS	
		READING	RUNNING	PSI	LBS					
7-4-75	1255	-	93	75	0	0	93	0.15	3	7500
	1305	10					93	0.15	3	↓
	1315	-					-	-	-	10000
	1325	20					102	0.25	5	
	1325	-					-	0.25	5	↓
	1335	10					114	0.35	7.5	
	1345	20					116	0.35	7.5	
	1355	30					116	0.35	7.5	↓
	1355	-					-	-	-	20000
	1405	10					121	0.35	7.5	
	1415	20					128	0.35	7.5	↓
	1425	30					128	0.35	7.5	↓
	1425	-					-	-	-	25000
	1435	10					141	0.35	7.5	
	1445	20					142	0.35	7.5	
	1455	30					142	0.35	7.5	↓
	1455	-					-	-	-	30000
	1505	10					152	0.4	8.5	
	1515	20					155	0.4	8.5	
	1525	30					155	0.4	8.5	↓
	1525	-	↓	↓	↓	↓	155	0.4	8.5	↓
8-4-75	0735	-	51	100	0	0	-	-	-	7500
	0745	10					100	0.35	7.5	
	0755	20					109	0.4	8.5	↓
	0755	-					-	-	-	10000
	0805	10					110	0.6	13.5	
	0815	20					110	0.6	13.5	↓
	0815	-					-	-	-	15000
	0825	10					126	0.65	14.5	
	0835	20					126	0.65	14.5	↓
	0835	-					-	-	-	20000
	0845	10					154	0.7	16	
	0855	20					156	0.7	16	
	0905	30					156	0.7	16	↓
	0905	-					-	-	-	25000
	0915	10					178	0.6	13.5	
	0915	20					172	0.6	13.5	
	0935	30					172	0.6	13.5	↓
	0935	-					-	-	-	30000
	0945	10					179	0.6	13.5	
	0955	20					178	0.6	13.5	
	1005	30					178	0.6	13.5	↓
	1005	-	↓	↓	↓	↓	-	-	-	30000
8-4-75	1245	-	59	125	0	0	104	0.15	3	7500
	1255	10					104	0.15	3	↓
	1255	-					-	-	-	10000
	1305	10					112	0.25	5	
	1315	20					-	-	-	15000
	1315	-					112	0.25	5	↓
	1325	10					140	0.35	7.5	
	1325	20					140	0.35	7.5	↓
	1335	-					-	-	-	20000
	1345	10					162	0.4	8.5	
	1355	20					162	0.4	8.5	↓
	1355	-					-	-	-	25000
	1405	10					165	0.4	8.5	
	1415	20					165	0.4	8.5	↓
	1425	30					207	0.45	10	↓
	1425	-					-	-	-	30000
	1435	10					198	0.45	10	
	1445	20					209	0.45	10	↓
	1455	30					209	0.45	10	↓
	1455	-	↓	↓	↓	↓	-	-	-	25000
8-4-75	0815	-	67	150	0	0	108	0.1	2	7500
	0825	10					108	0.1	2	↓
	0825	-					-	-	-	10000
	0835	10					118	0.15	3	
	0835	20					118	0.15	3	↓
	0845	-					-	-	-	15000
	0855	10					152	0.1	4	
	0905	20					152	0.2	4	↓
	0905	-					-	-	-	20000

TEST NO. 18 BRG. NO. 50 RETAINER LUG 1 INT CL 5 MILS DALL HOLE CL 10 MILS CAGE LAND CL 15 MILS GRIVES NO.

DATE	TIME READING	RUNNING	AXIAL LOAD PSI	RADIAL LOAD LBS	BEARING TEMP. PSI	I.R. LGS	O.R. LGS	BEARING TORQUE IN-OZ	SPEED RPM	REMARKS
9-4-75	0910	5	62	150	0	0		169	0.25	5 20000
	0920	15						174	0.25	5
	0930	25						175	0.25	5
	0930	-						-	-	28000
	0935	5						197	0.3	7
	0945	15						206	0.3	7
	0955	25						208	0.3	7
	0955	-						-	-	30000
	1005	10						224	0.5	11
	1015	20						298	0.6	19.5

Test stopped when Temperature exceeded 700°F

## TEST NO. 19 BRG. NO. 50 RETAINER W/G INT. CL 5 MILS BALL HOLE CL 10 MILS GAGE LAND CL 15 MILS SPACES 10

DATE	TIME	AXIAL LOAD READING PSI	RADIAL LOAD PSI	BEARING TEMP I.R. O.R.	BEARING TORQUE READING IN-OZ	SPEED RPM	REMARKS
10-4-75	1315	-	43	75	0	0	106 0.05 1 25000
	1325	10			106	0.05	1 ↓
	1325	-			-	-	10000
	1335	14			120	0.1	2
	1345	20			120	0.1	2 ↓
	1345	-			-	-	15000
	1355	10			146	0.3	7
	1405	20			188	0.3	7 ↓
	1405	-			154	0.3	7
	1410	5			168	0.35	75
	1415	10			176	0.35	7.5
	1420	15			182	0.4	8.5
	1425	20			174	0.25	5
	1430	25			182	0.45	10 ↓
	1430	-			-	-	15000
	1435	5			170	0.25	5
	1440	10			162	0.25	5
	1445	15			159	0.25	5
	1450	20			162	0.25	5
	1455	25			168	0.3	7
	1500	30			163	0.25	5 ↓
	1500	-			-	-	30000
	1505	5			197	0.3	7
	1515	10			258	0.6	13.5
	↓ 1525	20	↓	↓	258	0.6	13.5 ↓
11-4-75	0800	-	51	100	0	0	142 0.6 13.5 7500
	0810	10			148	0.6	13.5 ↓
	0810	-			-	-	10000
	0820	10			168	0.7	16
	0830	20			168	0.7	16 ↓
	0830	-			-	-	15000
	0840	10			182	0.7	16
	↓ 0850	20	↓	↓	↓	↓	↓

TEST NO. 2-0 | BRG. NO. 51 | RETAINER RATIO | INT. CL. 5 MILS | BALL HOLE CL. 1A MILS | GAGE LAND CL. 15 MILS | GROOVES NO.

DATE	TIME	AXIAL LOAD		RADIAL LOAD		BEARING TEMP.		BEARING TORQUE		SPEED	REMARKS		
		READING	RUNNING	PSI	LBS	PSI	LBS	I.R.	O.R.	READING	IN-OZ		
15-9-75	1300	-	51	100	0	0	0	170	0.2	4	40000	0	700.0
	1315	15						190	0.4	8.5		0.25	858.5
	1330	30						210	0.5	11		0.50	1110.0
	1345	45						228	0.5	11		0.75	1111.0
↓	1400	60						266	0.8	18.5		1.0	1868.5
15-9-75	0800	-						200	0.2	4			
	0815	75						240	0.2	4		1.25	444.0
	0830	90						260	0.3	7		1.50	727.0
	0845	105						266	0.2	4		1.75	944.0
	0900	120						292	0.3	7		2.0	727.0
	0915	135						292	0.25	5		2.25	565.0
	0930	145						294	0.25	5		2.42	565.0
	0945	155						282	0.3	7		2.58	727.0
	1000	165						286	0.3	7		2.75	727.0
	1015	180						284	0.3	7		3.0	727.0
	1030	195						290	0.3	7		3.25	727.0
	1045	210						272	0.3	7		3.50	727.0
	1100	225						300	0.3	7		3.75	727.0
	1115	240						318	0.3	7		4.0	727.0
	1130	255						344	0.3	7		4.25	727.0
	1145	270						348	0.3	7		4.50	727.0
	1155	285						319	0.3	7		4.75	727.0
	1200	300						294	0.3	7		5.0	727.0
	1215	315						278	0.3	7		5.25	727.0
	1230	330						270	0.3	7		5.50	727.0
	1245	345						291	0.3	7		5.75	727.0
	1260	360						314	0.3	7		6.0	727.0
	1275	375						298	0.3	7		6.25	727.0
	1290	390						300	0.3	7		6.50	727.0
	1305	405						310	0.4	8.5		6.75	858.5
	1320	420						295	0.35	7.5		7.0	858.5
	1335	435						297	0.35	7.5		7.25	858.5
	1350	450						312	0.4	8.5		7.50	858.5
	1345	465						298	0.4	8.5		7.75	958.5
	1360	480						298	0.4	8.5		8.0	958.5
	1375	495						352	0.55	12		8.25	1111.0
↓	1390	510						354	0.55	12		8.50	1111.0
16-9-75	0820	-						275	0.4	8.5			
	0835	525						300	0.5	8.5		8.75	858.5
	0850	540						304	0.4	8.5		9.0	858.5
	0905	555						318	0.5	11		9.25	1111.0
	0920	570						322	0.95	10		9.50	1111.0
	0935	585						306	0.55	12		9.75	1111.0
	0950	600						310	0.55	12		10.0	1111.0
	1005	615						296	0.55	12		10.25	1111.0
	1020	630						290	0.55	12		10.50	1111.0
	1035	645						288	0.4	8.5		10.75	958.5
	1050	660						276	0.5	11		11.0	1111.0
	1105	675						314	0.6	13.5		11.25	1363.5
	1120	690						290	0.55	12		11.50	1363.5
	1135	705						298	0.4	8.5		11.75	858.5
	1150	720						298	0.6	13.5		12.0	1363.5
	1205	735						316	0.5	11		12.25	1111.0
	1220	750						312	0.6	13.5		12.50	1363.5
	1235	765						322	0.55	12		12.75	1363.5
	1250	780						316	0.6	13.5		13.0	1363.5
	1305	795						314	0.6	13.5		13.25	1363.5
	1320	810						338	0.6	13.5		13.50	1363.5
	1335	825						316	0.6	13.5		13.75	1363.5
	1350	840						318	0.5	11		14.0	1111.0
	1405	855						322	0.5	11		14.25	1111.0
	1420	870						314	0.8	18.5		14.50	1868.5
	1430	880						-	-	-		14.67	-

TEST NO. 21 BRG. NO - RETAINER A/Hg INT. CL 5 MILS BALL HOLE CL 10 MILS GAGE-LAND CL 15 MILS GROOVES NO.											
DATE	TIME	AXIAL LOAD		RADIAL LOAD		BEARING TEMP.		BEARING TORQUE		SPEED RPM	REMARKS
		READING	RUNNING	PSI	LBS	PSI	LBS	I.R.	O.R.		
25-4-75	0730	-	51	100	0	0	0	-	-	40000	
	0745	15	↓	↓	↓	↓	↓	390	1.0	22.5	
	0750	Test stopped due to high Temperature & erratic Torque and speeds. ↓									
TEST NO. 22 BRG. NO 52 RETAINER INT. CL 5 MILS BALL HOLE CL 10 MILS GAGE-LAND CL 15 MILS GROOVES NO.											
25-4-75	1305	-	51	100	0	0	0	312	0.8	18.5	40000
	1320	15	↓	↓	↓	↓	↓	420	1.1	33.0	↓
		Test Time - 24 minutes Ball-shroud contact									
TEST NO. 23 BRG. NO 52 RETAINER INT. CL 5 MILS BALL HOLE CL 10 MILS GAGE-LAND CL 15 MILS GROOVES NO.											
27-4-75	1300	-	51	100	0	0	0	320	1.1	25.0	40000
	1315	15	↓	↓	↓	↓	↓	400	2.2	51.0	↓ Ball-shroud contact
TEST NO. 24 BRG. NO 51 RETAINER A/Hg INT. CL 5 MILS BALL HOLE CL 10 MILS GAGE-LAND CL 20 MILS GROOVES NO.											
28-4-75	0830	-	51	100	0	0	0	238	0.7	16	40000
	0845	15	↓	↓	↓	↓	↓	306	0.8	18.5	0.25
	0850	30	↓	↓	↓	↓	↓	318	0.8	18.5	0.50
	0915	45	↓	↓	↓	↓	↓	313	0.8	18.5	0.75
	0930	60	↓	↓	↓	↓	↓	310	0.8	18.5	1.00
	0945	75	↓	↓	↓	↓	↓	318	0.8	18.5	1.25
	1000	90	↓	↓	↓	↓	↓	310	0.8	18.5	1.50
	1015	105	↓	↓	↓	↓	↓	314	0.75	18.5	1.75
	1030	120	↓	↓	↓	↓	↓	310	0.8	18.5	2.0
	1045	135	↓	↓	↓	↓	↓	312	0.8	18.5	2.25
	1100	150	↓	↓	↓	↓	↓	314	0.8	18.5	2.50
	1115	165	↓	↓	↓	↓	↓	314	0.8	18.5	2.75
	1130	180	↓	↓	↓	↓	↓	320	0.8	18.5	3.0
	1145	195	↓	↓	↓	↓	↓	322	0.75	17	3.25
	1200	210	↓	↓	↓	↓	↓	322	0.75	17	3.50
	1215	225	↓	↓	↓	↓	↓	316	0.8	18.5	3.75
	1230	240	↓	↓	↓	↓	↓	318	0.8	18.5	4.0
	1245	255	↓	↓	↓	↓	↓	318	0.8	18.5	4.25
	1260	270	↓	↓	↓	↓	↓	330	0.8	18.5	4.50
	1315	285	↓	↓	↓	↓	↓	328	0.75	17	4.75
	1330	300	↓	↓	↓	↓	↓	330	0.75	17	5.0
	1345	315	↓	↓	↓	↓	↓	328	0.7	16	5.25
	1360	330	↓	↓	↓	↓	↓	319	0.7	16	5.50
	1415	345	↓	↓	↓	↓	↓	318	0.7	16	5.75
	1430	260	↓	↓	↓	↓	↓	328	0.7	16	6.0
	1445	375	↓	↓	↓	↓	↓	326	0.65	14.0	6.25
	1500	390	↓	↓	↓	↓	↓	344	0.65	14.0	6.50
	1515	405	↓	↓	↓	↓	↓	330	0.65	14.0	6.75
	1530	420	↓	↓	↓	↓	↓	324	0.6	13.5	7.0
29-4-75	0800	-	51	100	0	0	0	314	0.7	8.5	-
	0815	15	↓	↓	↓	↓	↓	336	0.7	8.5	7.25
	0830	435	↓	↓	↓	↓	↓	432	1.6	36.5	7.50
		Rub on cage OD. Melted Teflon on cage ID and wear tracks on outer race. one chipped 6 o'clock Unbalance of cage indicated.									
TEST NO. 25 BRG. NO 97 RETAINER A/Hg INT. CL 5 MILS BALL HOLE CL 10 MILS GAGE-LAND CL 20 MILS GROOVES 3 MIL											
1-5-75	0950	-	51	100	0	0	0	-	-	40000	
	1005	15	↓	↓	↓	↓	↓	430	1.6	36.5	↓
		Heavy rub on cage OD. Cage unbalance indicated.									